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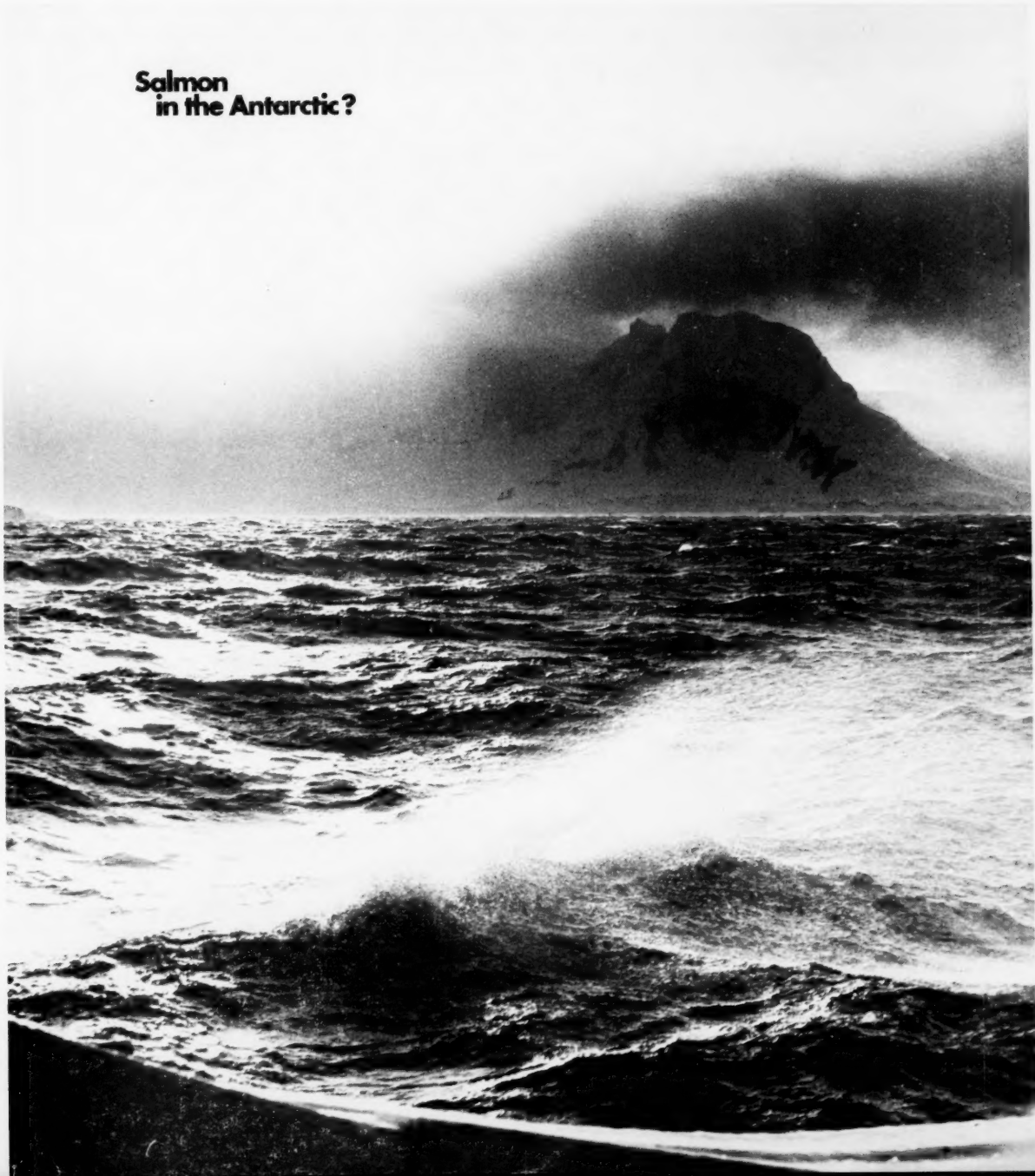
Salmon in the Antarctic?



Marine Fisheries Review

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CONTENTS

Articles

Cover.—The Antarctic seas should provide a suitable habitat for salmon—see article beginning on page 20. (Photograph courtesy of William R. Curtsinger, National Science Foundation.)

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MFR PAPER 1060

Success of the live-bait tuna fishery rides on the success of the fishery for bait.

Some Considerations of the Problems Associated with the Use of Live Bait for Catching Tunas in the Tropical Pacific Ocean

FRANK J. HESTER

ABSTRACT

This report provides a summary of tropical Pacific tuna live-bait fishing methods, identifies the major problems restricting the expansion of live-bait fisheries in the Pacific, and gives references and suggestions on methodology to investigators interested in working on baitfish problems.

INTRODUCTION

The use of live bait to catch tunas, called baitfishing in the eastern Pacific and pole-and-line fishing in the central and western Pacific, has been described by a number of authors (Godsil, 1931; June, 1951; Iwasaki, 1970; Isa, 1972; and Webb, 1972, 1973). The method probably was developed to its highest form in Japan from whence it spread, with modifications, across the Pacific and into the Atlantic during the first part of the 20th century.

The 1971 world tuna landings were 1,150,000 metric tons (FAO, 1971). Of this total catch, baitfishing accounted for about 244,000 metric tons (21%), purse seining took 228,000 metric tons (20%), and longlining took 427,000 metric tons (37%). The remaining 251,000 metric tons (22%) of tunas were taken by a variety of methods such as trolling, and traps and weirs, or were caught by the three principal methods but could not be so identified from the statistics.

For a description of tuna purse seining see McNeely (1961) and Green, Perrin, and Petrich (1971), and for tuna longlining, Shapiro (1950).

Live-bait fishing for tunas depends upon quantities of suitable baitfishes, which are used to attract schools of tuna to the boat and to excite them into a feeding mode so that they can be caught by lure and a pole and line. The principal tuna species taken with baitfishes are skipjack tuna, *Katsuwonus pelamis*; yellowfin tuna, *Thunnus albacares*; and albacore, *T. alalunga*. The live-bait albacore fisheries are in temperate waters. The discussion of live-bait tuna fishing in this paper will be limited to the tropical tunas—yellowfin and skipjack. Five elements of baitfishing for tunas will be reviewed and discussed: types of bait, catching the bait, holding and transporting the bait, fishing the tuna schools, and bait supply.

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TYPES AND CHARACTERISTICS OF A GOOD BAITFISH

In order to be a suitable live bait, the baitfish must be of a size and appearance acceptable to the tunas, its behavior must be such that the tunas are attracted to the boat and induced to bite, and the bait must be sufficiently hardy to remain alive during capture and transport. In this regard resistance to mechanical damage, i.e., loss of scales and bruising, is important, as is the bait's tolerance to temperature and temperature change so that the bait can be carried by the fishing boat from one fishing ground to another through waters of varying temperatures.

The preferred baitfishes for tuna fishing are clupeoids, principally the anchovies and their relatives. The clupeoids in general are good baits, being of the proper size (25-100 mm) and possessing the silvery appearance and the behavior that induces feeding behavior in the tuna. These fish are active swimmers that do not disperse when thrown into the water but maintain a semblance of schooling behavior and do not swim away or dive deep but stay close to the vessel.

When suitable supplies of clupeoids

Table 1.—Effectiveness of live bait.

Area and period	Bait species	Unit of measure	Quantity	Tuna catch (metric ton)	Effectiveness Kilogram bait/ metric ton tuna
Japan, 1968[1]	Anchovy, *Engraulis japonicus*	Bucket ≈ 5.5 kg	4.4×10^6 buckets	168×10^3	143.0
Japan, 1971[2]	do	Bucket ≈ 5.5 kg	250 buckets 1,375 kg	71.9	19.4
Hawaii, 1965-71[3]	Anchovy (nehu), *Stolephorus purpureus*	Bucket ≈ 3.5 kg	34×10^3 buckets 0.8×10^6 kg	4.5×10^3	28.50 $S^2 = 51$ (variance)
Eastern Pacific, 1948-59[4]	Anchoveta, *Cetengraulis mysticetus*	Scoop 4.1 kg	3.5×10^6 scoops 14.5×10^6 kg	114×10^3	128.1 $S^2 = 783$
Eastern Pacific, 1960-69[4]	do	Scoop 4.1 kg	0.41×10^6 scoops 1.7×10^6 kg	23×10^3	68.2 $S^2 = 158$
Palau Islands, 1966[5]	Anchovy (nehu), *Stolephorus heterolobus*	Bucket ≈ 3.5 kg	62.7×10^3 buckets 0.22×10^6 kg	2.9×10^3	87.4 $S^2 = 1008.8$
Ryukyu Islands, 1967[6]	Mixed—predominantly apogonids and lutjanids	Kilogram	0.27×10^6 kg	5.1×10^3	52.6
Hawaii, 1962[7]	Tilapia, *Tilapia mossambica*	Not available	Not available	Not available	≈ 60
Hawaii, 1968[8]	Shad, *Dorosoma petenense*	Bucket ≈ 3.5 kg	56 buckets 176 kg	4.8	37
Hawaii, 1971[9]	Shad, *Dorosoma petenense*	Bucket ≈ 3.5 kg	204 buckets 728 kg	12.5	58
Hawaii, 1973[10]	Northern anchovy, *Engraulis mordax*	Bucket ≈ 3.5 kg	3 buckets 10.5 kg	0.7	15
Hawaii, 1973[11]	Golden shiner, *Notemigonus crysoleucas*	Bucket ≈ 3.5 kg	Not available	Not available	118

[1] Based on total anchovy bait catch and total home and southern waters landings of yellowfin tuna, skipjack tuna, and albacore. (Source: [Japan.] Ministry of Agriculture and Forestry. Statistics and Survey Division, 1970.)
[2] Based on average bait capacity and average catch per trip of southern waters vessels (Anonymous, 1971).
[3] Source: Hawaii Division of Fish and Game and Bumble Bee Seafoods (1970).
[4] Source: Inter-American Tropical Tuna Commission (1956, 1960, 1966, 1970). Note: From 1960 on most of the large bait boats converted to purse seiners and left the bait boat fleet.
[5] Source: Congress of Micronesia (1972).
[6] Source: Isa (1972).
[7] Source: Shomura (1964). Quantity and weight of bait not given. Results are based on average catch rate comparison with nehu, nehu being considered to have an effectiveness of 30.
[8] Source: Iversen (1971).
[9] Source: Iversen, R. T. B. 1973. Commercial fishing for skipjack tuna with threadfin shad as bait. Unpublished report, 4 p. Southwest Fisheries Center, National Marine Fisheries Service, NOAA, Honolulu, HI 96812.
[10] Source: Uchida, R. N., Southwest Fisheries Center, National Marine Fisheries Service, NOAA, Honolulu, HI 96812, pers. comm.
[11] Source: Kato, K., Fishfarms Hawaii, P.O. Box 898, Kihei, HI 96753, pers. comm.

are not available, bait boats, especially those operating in island areas, resort to the use of any proper-sized fishes that can be obtained in reasonable quantity including a wide variety of tropical reef fishes such as juvenile mullets, Mugilidae; goatfishes, Mullidae; cardinalfishes, Apogonidae; damselfishes, Pomacentridae; silverside, Atherinidae; snapper, Lutjanidae; mosquitofish, Poeciliidae; rabbitfish, Siganidae; etc.

Baitfish acceptability is determined by three factors: supply, which is discussed in a separate section of this report, mortality, and effectiveness. Live bait is subject to continuous loss from the time it is obtained to the time that it is used for fishing. Strong bait, that is bait that survives capture and holding well, is in great demand. Studies of factors affecting mortality have been made by Baldwin, Struhsaker, and Akiyama (1971), and Anonymous (1971). Bait mortality is a complex problem and needs much additional work, particularly in connection with long distance transport and holding of large quantities of bait.

Effectiveness, that is the production of tuna per quantity of bait, is difficult to quantify owing to lack of good statistics on bait usage. From Table 1 it is apparent that there is a wide range of effectiveness expressed in kilogram bait per metric ton of tuna produced. The smaller the ratio the more effective the bait. These measures of effectiveness are subject to several biasing errors that result in an overestimate of the bait needed. The largest error is due to the use of total bait caught rather than bait used in fishing. Thus mortality is included in these estimates.

Also included is bait dumped when fishing is completed.

Sources of error that affect the variance of the estimates are the size of the tuna fished, more bait being required to take a ton of small tuna, the reporting of bait catches by the bucket or scoop, the constancy of which is questionable, and the complex relation between bait mortality and time spent looking for fish. The latter may account in part for the increase in effectiveness in the eastern Pacific fishery after 1960 when the bigger boats dropped out of the fishery leaving as the principal users of bait the smaller boats that perhaps did not spend as much time scouting for tuna.

BAIT CATCHING METHODS

Baitfishes are caught by several types of gear, the most common being the bait seine. The details of this type of gear and operation vary from locality to locality. In Hawaii the so-called day net, a round-haul net for shallow water that lacks wings, bag, or purse line, is used. The dimensions for a typical day net are 175 by 4 m constructed of 4.8 mm stretched mesh webbing (Figure 1). The main bait species taken is the nehu, an anchovy, *Stolephorus purpureus*, which is quite small and requires a small-meshed net. Another common bait net, used chiefly in the eastern Pacific, is the lampara, which has wings and a bag section, is deeper, and can be used in waters where the leadline does not necessarily maintain contact with the bottom. Details of the operation using this gear are given by Scofield (1951) and Du Plessis (1959).

For baiting in deep water, the purse seine is effective, being superior to the lampara but requiring more manpower. For shallow water areas where the bottom is too rough to drag or walk the leadline of the net, the drive net is used (Figure 2).

"The 'drive-in-net' fishing method is said to have been developed in the Ryukyu Islands (Shapiro, 1949) to catch shoaling fishes in coral reef areas. Divers, sometimes carrying fish-chasing devices, drive the fish school into a net set strategically to block the path of the fish. As soon as the fish are driven into the net, the net is lifted to the surface. This method has long been used for catching mainly the Apogonidae and Caesionidae. The size and design of the net differ according to the fish to be captured. The net usually consists of a bunt and two wings when catching larger and faster swimming fishes such as adult *Caesio*, flyingfish, and garfish. Only the bunt of the net or a blanket net is used for catching apogonids or other slower swimming fishes or juvenile fishes. The drive-in net is used to capture apogonids early in the morning by taking advantage of their nocturnal habit. The bait fishermen cover a reef with the net before sunset. The fish are found hiding in crevices. The net is allowed to remain overnight. The opening over the crevice in which the fish are hiding is kept open in order to enable the fish to move out at night. The fishermen catch the baitfish early in the morning by driving the fish into the net before the fish can return to their hiding places.

"The fishermen also catch the apogonids during the day by inserting tree leaves into crevices and scaring them out. Some apogonids are observed during the day with other baitfish and are caught along with them. The red scads (*Caesio*) and 'blue bait' are caught during the day." Isa (1972).

A second type of baiting operation is night baiting, commonly used in coral-island areas. In this operation a strong underwater light, 750-1,500 w, is submerged to as deep as 20 m below the surface and allowed to remain until a quantity of bait has been attracted. The light then is slowly drawn up toward the surface near a net suspended vertically in the water. The net typically is of 6.4 mm mesh and nearly square, being about 25 m on a side. Once the light and bait are at the surface, the net is raised under the bait (Figure 3). For details of this method see June (1951).

Catching bait for tuna fishing is dependent primarily on the availability of quantities of bait and not on the lack of a suitable method of taking them; i.e., the methodology

Figure 1.—Hawaiian-type day net being set on the reef for iao, a small atherinid.

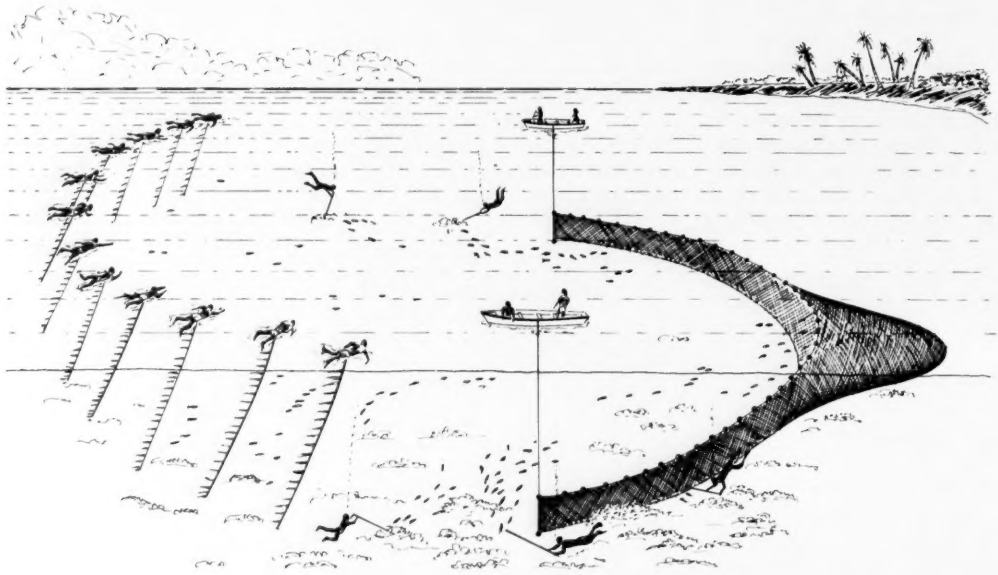


Figure 2.—Catching bait with a "drive-in" net.

has been well worked out and usually presents a minor problem to a bait boat. However, there are some exceptions. These include the introduction of, or the learning of, methods suited for certain areas by fishermen from other areas. For example, the Okinawan live-bait fishermen are generally believed to be the best or most knowledgeable for operating in coral island areas where they manage to find and take bait when fishermen from Japan or the United States would fail. In part their success lies in the use of wall nets (Isa, 1972) suspended near coral heads or close to drop-offs. Also, they are adept at the swim-in method of bait catching (*ibid.*). Even when more desirable baits are absent they are able to take small quantities of bait by tearing apart coral heads. This practice is not to be recommended but is used at times. Species taken in this manner include small damselfish and cardinalfish.

A source of bait that might be used if the catching techniques could be developed occurs offshore where schools of clupeoids and carangids exist in considerable abundance and sometimes come to a light. Also it is frequently observed that floating objects attract quantities of small fish, and it may be that natural or artificial floating "logs" together with a lampara or purse seine might be used to obtain bait. It may be possible to develop a night-light, lift-net operation or a deepwater lampara or seine operation that could provide supplies of offshore bait at certain times in certain places. Night baiting using deeply submerged lights either inshore or offshore is undergoing further refinement in some areas. In addition, the use of set nets, or weirs, may hold promise in areas where the bait species are migratory either along the shore or inshore-offshore.

HOLDING AND TRANSPORT OF THE BAIT

Once the bait is in the net, it must be transferred to holding tanks or wells (eastern Pacific and Japan, Figure 4) or "boxes" (central-western Pacific) aboard the vessel or into receivers if it is not to be loaded on the vessel immediately. When the baitfishes are hardy, as is the case with most of those taken in the eastern Pacific, the transfer from the net to holding tanks or receiver is accomplished with a dip net or scoop. In the 1950's at the height of the bait boat era in the eastern Pacific a scoop held about 4 kg of bait and was the common unit of measure used. Today

with the trend towards smaller bait boats the scoops are smaller and hold 1-2 kg. Elsewhere, where the bait species are more delicate and subject to high mortality by abrasion and bruising (the tropical clupeiods with their highly deciduous scales are particularly susceptible), the transfer is made by the use of buckets. These are generally of seamless stainless steel with a capacity of about 15 liters. The bucket keeps the fish mixed with sufficient water to reduce scale loss and bruising. In areas such as Hawaii and Japan, the bucket is the common unit of measure for baitfishes. The bucket holds on the average 3.5 kg of bait in Hawaii and 5.5 kg of bait in Japan although, as with the scoop, the actual amount is quite variable.

Injury and shock during transfer of the bait into the holding tanks or receivers account for most of the mortalities. Losses can be very high if the bait has been handled carelessly. Bucketing appears to reduce mortality as does increasing the amount of oxygen in the holding tanks, reducing the temperature, lowering salinity, and avoiding crowding and undue excitement of the bait until it has had a chance to acclimate to its new environment. For discussion of ways of reducing the rate of mortality associated with the Hawaiian live-bait fish nehu, *S. purpureus*, see Baldwin et al. (1971). In addition, methods of avoiding brailing or bucketing bait from the net to the wells could stand closer examination. For example, the swim-aboard technique used by the west coast bait haulers might be adapted to commercial baitfishing operations. This is a method where the fish enter the well through a gate at the waterline of the vessel thereby avoiding the brailing operation.

Some work has been done in transferring bait by means of pumps (Baldwin, 1969). Whether or not this

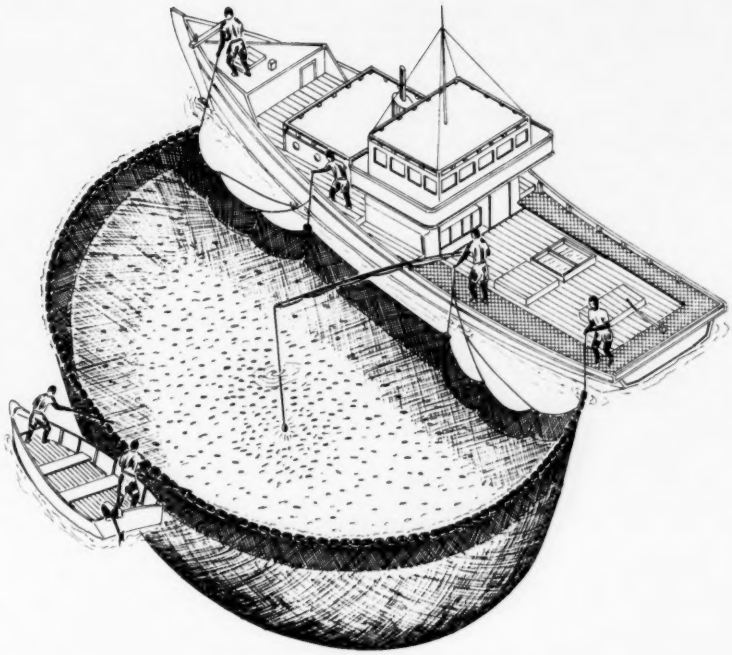


Figure 3.—Night baiting with a Hawaiian-type lift net.

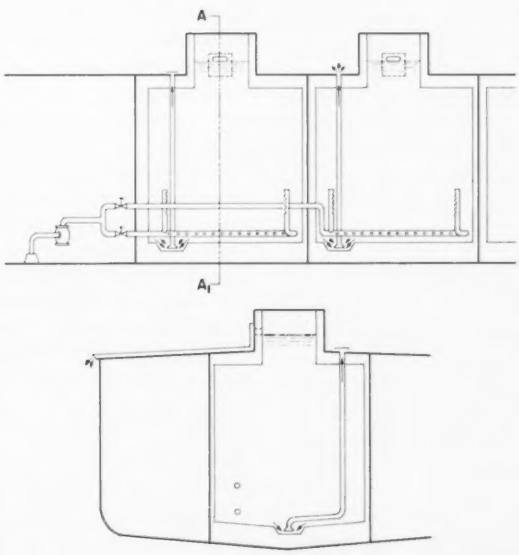
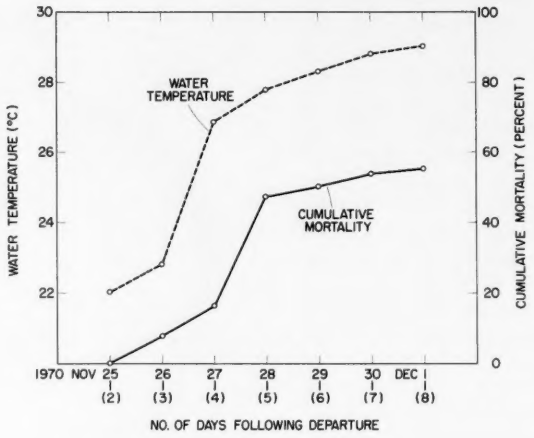


Figure 4.—Japanese bait boat wells showing the perforated inflow pipe, overflow, and "bilge"-pipe for continuous removal of dead bait. (From Miho Shipbuilding Co., 1966.)

Figure 5.—Relation between water temperature and bait mortality on a vessel traveling from Japan to the southern water gounds. (From Anonymous, 1971.)



would result in reduced mortality is open to investigation. It certainly would speed up the loading operation.

In holding baitfish aboard vessels, there are a number of factors that are important. First is the supply of water. In the central and western Pacific with the older Japanese, Hawaiian, and Okinawan style vessels, water comes in through holes in the boat at the bottom of the boxes, circulation being assured either by the motion of the vessel through the water or the rolling of the vessel by wave action. The amount of oxygenated water supplied in this manner is adequate for small quantities of bait held for short periods. With the vessels of the eastern Pacific and the newer Japanese pole-and-line vessels that carry large quantities of bait over great distances, circulating seawater is supplied by pumps to the wells. As a general rule, a turnover of the water in the wells 5 to 10 times an hour is desirable. Typically, a 10-m^3 well would have a water exchange at the rate of about 1,500 liters per minute. The carrying capacity of a well with forced circulation varies from 10 kg of baitfish per cubic meter of water to as high as 50 kg per cubic meter. Capacity is affected by water temperature (Figure 5), the species and condition of the bait, and the sea state, high mortality of the baitfish occurring during rough weather. Proper lighting in the wells also is an important factor in reducing mortality.

If the bait is to be maintained for an extended period of time it is necessary to feed it. This is a problem particularly in the eastern and western Pacific where large bait boats will try to keep bait aboard for several weeks. Foods used vary from chopped fish to bread and meal and prepared fish chows.

It is important that the bait be rested before the trip begins. This is frequently done by holding the bait in receivers or in the tanks for several days prior to departure from the baiting grounds. In the Japanese southern water fishery, for example, where the vessels transport their bait from Japan to the tropical western Pacific, the bait is rested in receivers for several weeks prior to departure.

Another source of mortality that can present a problem in the central and western Pacific occurs when the bait comprises a mixture of species. If the mixture involves larger predatory fish together with the smaller desirable bait species, the larger predators will either eat or frighten the bait resulting in a high mortality. Also not uncommon are instances where juvenile lae, *Scomberoides sancti-petri*, a small carangid, is taken with the bait and causes high or complete mortality by biting the scales off the baitfish (Struhsaker, Baldwin, and Murphy, unpublished[1]). Development of satisfactory separators to separate the desirable from the undesirable species needs investigation.

For chumming, the baitfish are crowded with a small net or "crowder" so that they can be easily brailed out. With some species this causes an extreme fright reaction and high and rapid mortality. The sprats, *Spratelloides* sp., called piha in Hawaii, are plentiful and ubiquitous throughout the central and western Pacific. However, these are very delicate baitfish that die within a few hours of loading into the well. In part the mortality occurs during crowding for chumming and if this mortality could be alleviated, these plentiful fishes would represent a major increase in bait supply throughout the island areas.

A so far neglected area for investigation is the use of drugs to lessen the fright reaction and metabolic requirements of baitfishes. For example, the use of anesthetics and tranquilizers in the transport of trout, salmon, and other freshwater fish is more or less routine, whereas this is not the case in the transport and holding of marine baitfishes.

FISHING OPERATIONS—CHUMMING

Baitfishing for tunas depends upon locating surface tuna schools. Once the school is located, a portion of the bait in the well is crowded with

[1] Struhsaker, J. W., W. J. Baldwin, and G. I. Murphy. n.d. Environmental factors affecting stress and mortality of the Hawaiian anchovy *(Stolephorus pupureus)* in captivity. n.p. Completion report prepared for National Marine Fisheries Service under Commercial Fisheries Research and Development Act (P.L. 88-309), Project H-10-R. Hawaii Institute of Marine Biology, University of Hawaii, Kaneohe, HI 96744.

a net into a reduced area where it can be dipped out with a dip net. Small amounts of bait are tossed into the water in such a way as to bring the tuna to the boat. Chumming techniques vary somewhat with area and with the type and quantity of bait available. Various tricks are used to alter the behavior of the bait to make it attractive to the tunas. A good chummer has techniques that produce tuna at a rate that an inexperienced chummer cannot match.

The handling of the boat varies with area, too. In the eastern Pacific and in Hawaii the vessel moves slowly ahead and fishing is conducted from the stern. In the Japanese- and Okinawan-type fishing the vessel is stopped dead in the water and fishing is conducted along one entire side from the stern to the end of the extended bowsprit. The crewmen aboard Japanese- and Okinawan-style boats generally number 3 to 5 times the men aboard a Hawaiian- or west coast-style bait boat. Production figures per day's fishing between the two methods are generally comparable, however. It is believed that the use of bait by the eastern Pacific boats is more profligate than by the Hawaiian or oriental boats and indeed there appears to be some truth to this belief (Table 1). However, the number of baitfishes thrown per school is probably near equal owing to the different size of the fish used. Good data are not available for the Japanese southern water fishing vessels.

It is interesting to note that the use of a water spray system (Yuen, 1969) throughout the central and western Pacific is absent or very uncommon in the eastern Pacific. Whether or not the vessels would be more productive in the eastern Pacific if water sprays were used is not known, but comparison between fishing with and without the water spray shows that it indeed does affect the catch rate in Hawaiian waters (*ibid.*).

SUPPLY

The major problem in baitfishing is obtaining a sufficient and dependable supply of bait. Discussed in this section will be natural bait, rearing of bait, transport of bait, and artificial bait. The introduction and establishment of nonendemic bait species will not be considered. Pertinent to any discussion of supply is the question of the value of the bait to the fishermen. How much is it worth to the fishing operation to have bait aboard? Obviously without bait there can be no production of tuna and therefore no income. A number of studies have been undertaken in order to assign some value to the bait. The methodology used includes the empirical approach, the examination of what fishermen are willing to pay for bait available for sale; the opportunity cost approach, what catching bait costs the vessel in terms of lost fishing time; and the marginal product approach, a method that gives a maximum value for bait.

Live bait is sold to commercial fishing operations in Japan and to a lesser degree on the west coast of the United States. In the case of the former, the vessels pay about $10 per bucket ($2 per kg) at the bait seller's receiver. The bait then has to be transported to the fishing grounds and may undergo considerable mortality, typically 20% to 30% but at times much higher. On the west coast of the United States the selling price of bait may be as low a $2 per scoop ($0.50 per kg), the amount of bait in the scoop being less than the Japanese bucket. Again, the buyer has to accept the mortality during transport from the bait seller to the fishing grounds. During a recent experiment where northern anchovy, *Engraulis mordax*, was brought in from California to Hawaii, the vessels were willing to pay $20 per bucket.

With the exception of Japan it appears to be more traditional for each vessel to carry its own bait net and bait skiff and to catch its own bait. Under these circumstances it is possible to estimate the cost of catching the bait based on the time lost to fishing. For example, in Hawaii, studies suggest that between 25% and 30% of the time available for fishing is spent searching for and catching bait. This puts the cost per bucket of bait between $12 and $30 ($3.50 and $8.50 per kg) (Brock and Takata, 1955; Shang and Iversen, 1971). Similarly studies in Hawaii based on the production function method suggest that the value of a bucket of bait is as high as $80 ($23 per kg) to the vessel (Elliott, Keala, and Matsuzaki, unpublished[2]). Because of the wide range among these figures, for planning purposes a good estimate is $10-$20 per bucket ($3-$6 per kg). It is questionable whether refining these cost estimates is worthwhile at this point since the sociological problem of convincing fishermen to purchase bait appears to be greater than convincing them that the bait is worth so many dollars per bucket based on their fishing operation. Past experiments for example whereby the State of Hawaii raised tilapia, *Tilapia mossambica*, for bait (Brock and Takata, 1955; Shomura, 1964) and made it available to the vessels at a nominal price failed, not because the price of the bait was too high but because the fishermen felt that the bait they could catch was superior and free. Since then their attitude towards the purchase of bait has changed to a great degree.

Natural Bait Supplies

The location of abundant natural baits (Table 2 and Figure 6) is of prime concern for the expansion of bait fisheries in the central and western Pacific. The location of bait usually depends upon bait surveys, which

[2] Elliott, D. P., B. A. Keala, and C. Matsuzaki. n.d. Estimation of demand for live bait to be used in the skipjack fishing industry. 21 p. [Technical report submitted to Southwest Fisheries Center, National Marine Fisheries Service, NOAA, Honolulu, HI 96812.]

Table 2.—Availability of bait for live-bait fishing in the Pacific and Indian Oceans.

Area[1]	Kinds of baitfish	Commercial landings	Used for live bait	Potential
1 Indian Ocean	Anchovy, sardine, herring	>100,000 metric tons	?	Very good
Minicoy, Laccadive Is.	Reef fishes—apogons, damsels, etc.	Limited amount	Yes	Limited, small fishery
2 Southeast Asia	Anchovy, sardine, herring	>40,000 metric tons	?	Very good
3 Japan: Northeast	Anchovy, *Engraulis japonicus*	7,299 tons	1,970 tons	**Excellent**
Central	do	73,541 tons	10,857 tons	**Excellent**
Southwest	do	144,508 tons	11,200 tons	**Excellent**
4 Formosa[2]	Anchovy	?	?	?
5 South Korea[3]	Anchovy	?	?	?
6 Philippine Is.	Anchovy	20,000 metric tons	?	Very good
7 Marianas	Rabbitfish, etc.	?	?	Very poor (highly seasonal)
8 Western Carolines	Anchovy, sardine, silverside, round herring, etc.	?	Est. >100,000 buckets	Good
9 Eastern Carolines	do	?	?	Poor, OK for small scale operation
10 New Guinea[4]	Anchovy, sardine	?	?	?
11 Fiji	Anchovy, sardine, silverside, mackerel, etc.	?	Experimental	Good
12 Solomon Is.[5]	Sardine	?	Yes	?
13 Gilbert Is.[6]	Sardine	?	?	?
14 Phoenix Is.	Goatfish, mullet, etc.	?	?	Poor
15 Marshall Is.	Sardine, silverside, round herring, etc.	?	Experimental	Good
16 Samoa	Sardine, anchovy, mackerel, etc.	?	Experimental	Poor
17 Society Is.	Mackerels, round herring, etc.	?	Experimental	Poor
18 Tuamotu Archipelago	Goatfish, mullet, round herring	?	Experimental	Poor
19 Marquesas Is.	Sardine	?	Experimental	Good (seasonal)
20 Line Islands	Goatfish, mullet, etc.	?	Experimental	Poor
21 Hawaii	Anchovy, silverside, round herring, etc.	?	ca. 35,000 buckets (130 metric tons)	Good
Leeward Is.	Silverside, mullet, goatfish, etc.	?	Experimental	Poor
22 Eastern Pacific: California to Panama	Anchovy, anchoveta, sardine	>200,000 metric tons	4,000,000 scoops (14,500 metric tons)	Excellent
23 Southeastern Pacific: Panama to Chile	Anchoveta	Est. 10,000,000 metric tons	600,000 scoops (2,200 metric tons)	Very good

[1] See Figure 6.
[2] The Japanese mention Formosa as a possible baitfish source.
[3] The Japanese mention Pusan as having a good supply of strong bait.
[4] The Japanese operate several boats in this area.
[5] The Japanese have 6 boats in this area; will increase to 11.
[6] The Japanese have been operating in the area.

may give misleading results unless they extend over a long time span. Survey methods include full-scale catching operations, diver surveys, interviews with inhabitants, aircraft, beachwalking, etc. Examples of recent bait surveys are [Japan.] Fisheries Agency (1969), Hida (1971), Wilson (1971), and Kearney, Lewis, and Smith (1972). Problems with surveys include the seasonal or cyclic changes in abundance of species whereby certain areas that may have plentiful quantities of bait one day, may have none the next. Too, the amount of bait may vary from year to year or over a many-year period. Even when baitfishes are located in quantity, the question still arises as to the amount of bait that can be taken. Few if any population dynamics studies have been done on tropical bait species. Perhaps the most intensive involved the anchoveta in Central America (Bayliff, 1966), and a study of the tropical anchovies in Palau by Garth I. Murphy (University of Hawaii, Honolulu, HI 96822) is still in progress. Most of these fisheries appear to be capable of tol-

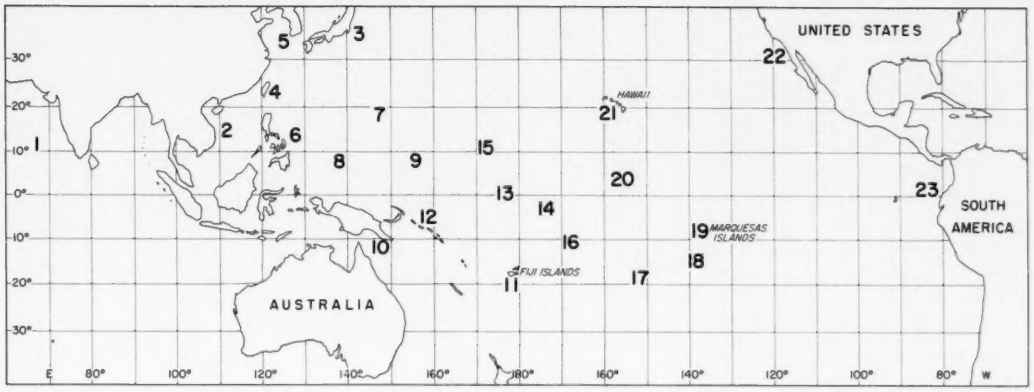


Figure 6.—Areas of baitfish availability. Numbers refer to Table 2.

erating high fishing mortality; however, better information is needed before it will be possible to manage these resources. For much of the Pacific, however, supplies of natural baits are less than required for maximum tuna production.

Aquaculture

Aquaculture is a possibility for supplying baitfishes in areas where natural baits are limited or lacking. The problems here are threefold, namely rearing a baitfish that is an acceptable bait for tuna, producing it at a competitive cost and producing it in sufficient quantity to support a number of tuna boats. The provisional bait price developed above, about $15 per Hawaiian bucket ($4.50 per kg), is sufficiently high that aquaculture should be an economically acceptable solution.

Mass rearing probably presents minimal difficulties because of a fairly extensive background in the production of fish through aquaculture.

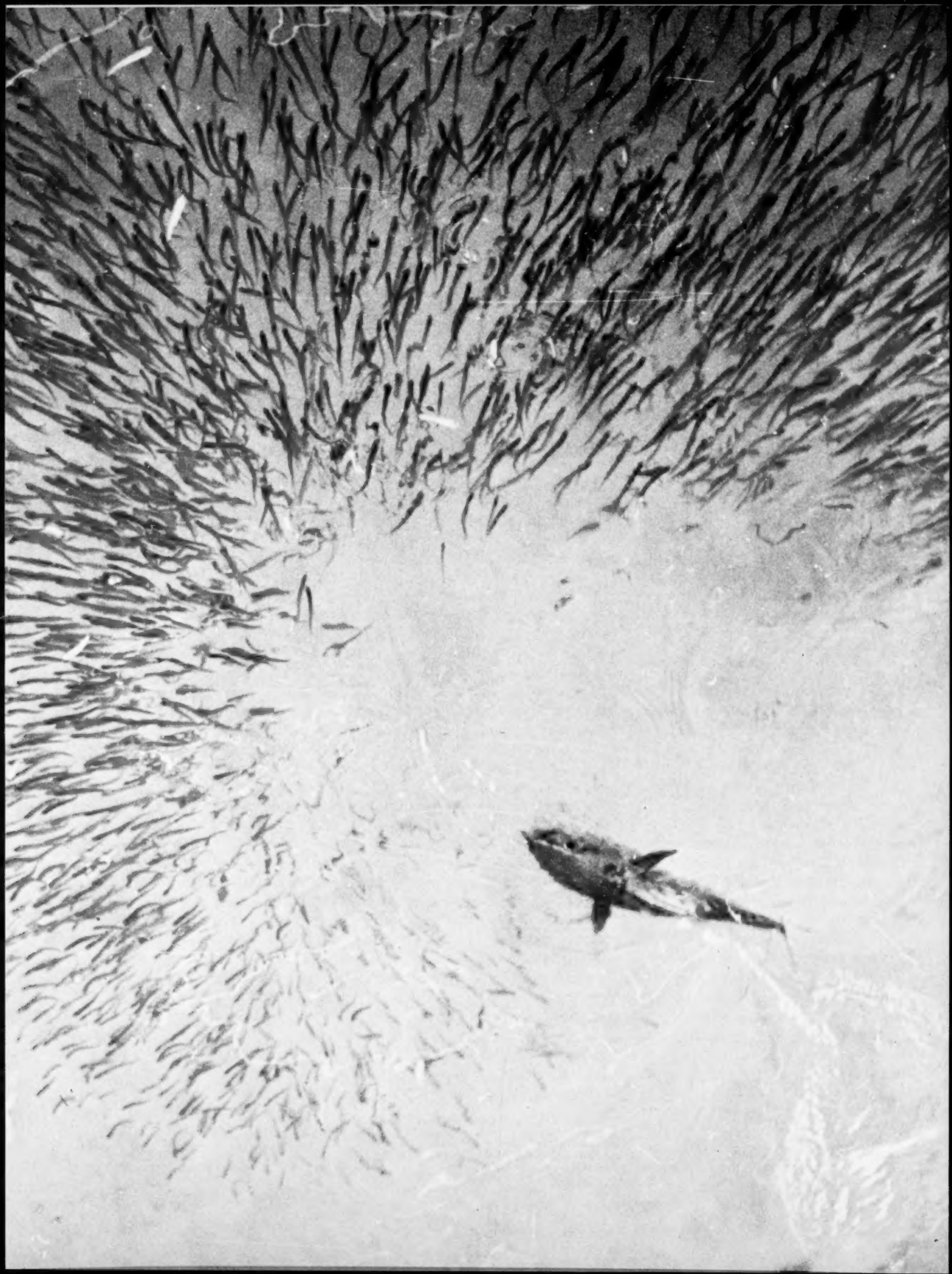
Acceptability as discussed previously covers both mortality and effectiveness. With the Hawaiian nehu, mortality typically runs 25% per day in the baitwell, suggesting that a hardier bait produced by aquaculture that suffered only a 5% mortality rate could be 20% less effective in the production of tuna and yet be acceptable. Similarly, a less effective bait that could be produced at lower cost than nehu might, from the standpoint of economics, be an acceptable substitute bait.

In selecting a species for aquaculture, consideration has to be given to those factors affecting its acceptability, that is, hardiness and effectiveness, and those factors affecting its production, for example, can spawning be controlled? Are there difficulties in production of the young? Does it grow to an unacceptable size, etc.? Work has been done with several species—tilapia (King and Wilson, 1957), threadfin shad (Iversen, 1971), commercial sharpnosed molly (Herrick, unpublished[3]). Other species considered or tested include carp, fingerling catfish, juvenile mullet and goatfish, and golden shiner. The difficulties lie in finding species that can be raised in quantity and in devising a quantitative measure of their acceptability. For screening, a method that appears practical at present, since the characteristics of a good baitfish are poorly defined, is a series of field tests whereby sufficient quantities of bait are used in sea trials to determine its relative acceptability, that is, its mortality and effectiveness.

For work in Hawaii and using nehu as a reference bait from Table 1, it would appear that 30 kg of nehu will produce a metric ton of tuna. Screening experiments should include alternate uses of nehu and the subject bait over an extended period of time. The variance of catch rates for tuna boats is high and screening tests of the proper sensitivity cannot be conducted with small amounts of bait. In order to give an indication of effectiveness 200 buckets or enough for approximately 5 days of fishing is suggested. This will provide an initial indication as to the desirability of continuing with the species or abandoning it. The difficulty in making such a judgment is pointed out in our experience with threadfin shad whereby the results obtained during 1 year with shad aboard RV *Charles H. Gilbert* and during another trial using a commercial vessel gave different answers.

The desirability of using a saltwater versus a freshwater or a euryhaline species needs consideration since production in fresh water may present fewer problems than in salt water, the methods being better developed, and there are many freshwater species that appear to possess the characteristics desirable and necessary to be good tuna bait. However,

[3] Herrick, S. F., Jr. 1972. Economic analysis of commercial molly *(Poecilia sphenops)* baitfish aquaculture. 11 p. and attachments. Hawaii Institute of Marine Biology, University of Hawaii, Kaneohe, HI 96744.



(Opposite) Kawakawa and baitfish in tank. Tank is used for studies of behavior of fishes, including tunas.

in many island areas, sufficient fresh water for mass rearing is lacking and culture would have to be conducted in salt or brackish water. Also, there would be difficulty in maintaining fresh water in the baitwells aboard the vessel.

Transport

Another approach to bait supply is the transport of quantities of bait from an area where it is plentiful into the area of the fishery. In effect this is done in both the eastern and western Pacific by larger bait boats that bait in coastal areas and then carry the bait to the fishing grounds. The next step in this process is to transport the bait aboard a bait carrier to an area in the fishing grounds where it can be sold to the fishing vessels. This approach has not been examined in detail but it appears that using a $4.50 per kg bait price this may be feasible. This figure is based on data from the Hawaii fishery where bait usage is low owing to the large, 7 kg and up, skipjack tuna constituting the bulk of the "season fish." In areas where the average weight of the skipjack tuna is less the "value" of the bait may be expected to drop. Therefore, the profitability depends upon the amount of bait that can be carried in a given volume of water, the anticipated mortality during transport and holding at the final destination, and the value of the bait determined by its effectiveness. To evaluate such operations it is necessary to look both at the economics of shipping and the fishery, and at mortality during capture, loading, transport, unloading, and holding. Experiments conducted by the Honolulu Laboratory in transporting northern anchovy from California to Hawaii suggest that mortality in shipment may be acceptable. These shipments were made using commercial fishing vessels, which took approximately 10 days to make the crossing. Commercial shipping lines can make the crossing in about 4 days. The advent of roll-on, roll-off service between the mainland and Hawaii, for example, suggests that transport of anchovy might be practical aboard these vessels. Similarly the advent of LASH (lighter aboard ship) service to French Polynesia and American Samoa suggests that it might be feasible to ship bait from California, Latin America, or Australia to these areas. See Figure 7 for a diagrammatic summary of the preceding discussion.

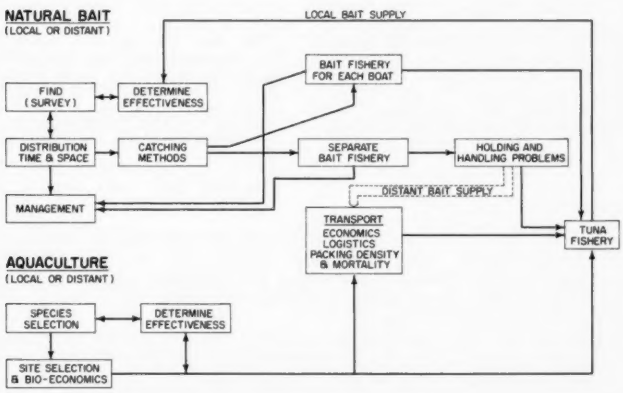


Figure 7.—Diagrammatic representation of alternative bait supply considerations.

Artificial Bait

The use of dead or inanimate substances and new live baits to replace conventional bait for surface tuna fishing should be considered. Early attempts such as those conducted at the Honolulu Laboratory in the 1950's (Tester, Yuen, and Takata, 1954) were unsuccessful, but these studies cannot be regarded as exhaustive and further experimentation should be supported. It is possible that dead baitfish or objects resembling baitfish could be made to sink and rise or move in the water so as to resemble a live baitfish. Incorporation of a scent into the objects or the use of dead bait for this purpose might serve to supplement live bait or even to replace it.

New Baits

The use of animals other than fish for bait has been suggested. Shrimp or large brine shrimp might prove to be an acceptable bait. Similarly crustacea that can be held in suspended animation or in the egg for extended periods of time might prove to be a valuable adjunct to live-bait fishing for tuna. The advantage here is that these types of animals can be produced almost upon demand and in large quantities from a small initial volume. Studies along these lines appear worthy of support although the probability of success is less likely than with aquaculture or transport.

SUMMARY

The use of live bait to catch tunas accounts for over 20% of the world tuna production. This method is especially suited for areas where tuna schools cannot be caught effectively using more efficient, that is, capital intensive, gear such as the purse seine.

Dependable supplies of acceptable

live bait are the key to successful baitfishing. Acceptable bait species are those that can be held and transported with low mortality and are effective in catching tunas, that is, the ratio of bait used to tuna caught is minimal.

Dependable supplies of natural bait do not occur in the newest tuna fishing grounds in the tropical Pacific. Ways of providing a supply include aquaculture, importation of bait from other areas, and development of artificial baits. All of these alternatives are subject to the economic constraint of an estimated $4.50 per kg value of baitfish delivered to the fishing vessel, and require varying amounts of research before they can be considered feasible. Also needed are better reporting statistics from presently used baiting grounds and the continued search for new supplies of natural bait.

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MFR Paper 1060. From Marine Fisheries Review, *Vol. 36, No. 5. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*

MFR PAPER 1061

Two types of fish trays are compared for cooling rates and effect on shelf life.

Polyethylene Trays for Flounder Fillets

DANIEL W. BAKER II, JOHN A. PETERS, and ALLAN F. BEZANSON

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INTRODUCTION

Recently introduced polyethylene containers appear to be well suited for distribution of fish. They are light in weight, nest together when empty (consequently requiring less storage space than the usual container), are not subject to corrosion, and the cover is heat-sealed to the container to make them leakproof. They are also considerably less expensive than the customary metal containers.

Acceptance of plastic containers has been slow because there have been claims that plastic containers are responsible for shortening the shelf life of fish fillets; in addition, although it is known that heat transfer through plastic is slower than through metal, the cooling rate of fillets in these containers is not known. Therefore, we decided to determine the shelf life and the cooling rates of flounder fillets packed in the conventional metal can and the new plastic container.

PROCEDURE

Arrangements were made to obtain fish samples packed in both rectangular plastic 20 pound capacity trays with heat-sealed covers and standard round metal 20 pound capacity cans.

Four sets of 2-day-old flounder fillet samples were obtained for tests. Two sets of samples were packed in round cans while the remaining two sets of samples were packed in the rectangular plastic trays. All the fish were at 58°F when packed. All the containers were flooded with 60°F (16 percent sodium chloride) brine. The cans were then covered with a tight fitting metal lid, and the plastic trays were covered with polyethylene sheets heat-sealed to the trays.

All of the trays and cans were then packed in insulated containers and transported to the Center for cooling and storage tests. The cans were stacked one on top of the other in ice, but with no ice between them. The plastic containers were similarly packed, except that the top container was turned bottom up so that the top surfaces of the containers were face to face.

At the Center, thermocouples were placed in the containers so that the temperature gradient through the containers could be determined. Figure 1 shows the location of each of the thermocouples. The trays and cans were then repacked in ice in the same order as they were originally, except a large open top fiberboard box was substituted for the insulated containers. They were then stored for 48 hours to obtain cooling rates for the fillets in the two different containers. After 48 hours, temperature monitoring was discontinued and a series of organoleptic tests were started.

Cooling rates of the fillets packed in the plastic trays and in the metal cans are shown in Figure 2.

Samples were removed for organoleptic evaluation after the 48 hour cooling test and thereafter on the 5th, 7th, 9th, and 12th days, at which time tests were discontinued as the fish were rated unacceptable.

OBSERVATIONS

Comparison of cooling rates showed nearly identical curves for both sets

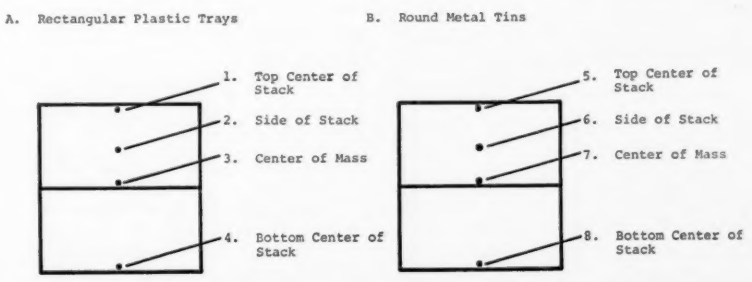

Figure 1.—Thermocouple locations in trays and tins containing flounder fillets.

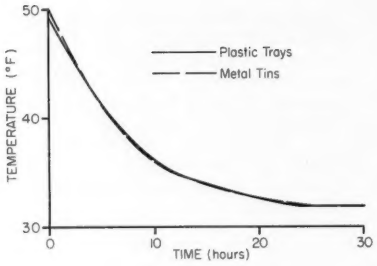

Figure 2.—Comparison of cooling rates in the center of the mass of flounder fillets.

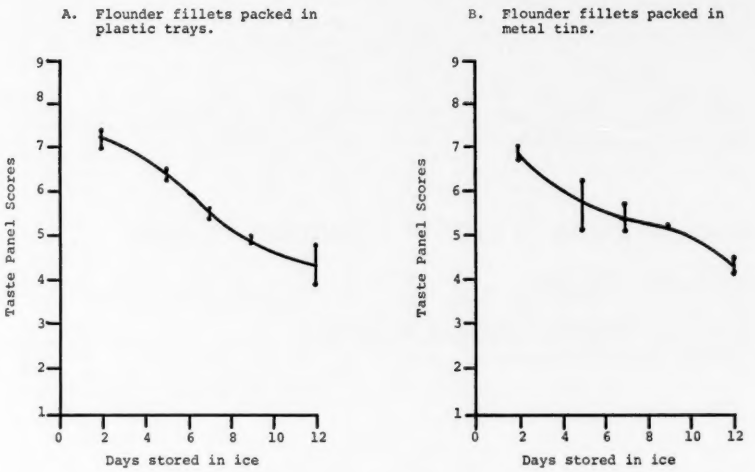

Figure 3.—Averages of taste panel scores for odor, flavor, texture, and appearance. Vertical lines indicate range of averages for the various samples at each test.

of samples. Initial temperatures of each set of samples varied from about 35°F on the surface to 50°F in the center. This was owing to initial cooling of samples, mostly surface, during the transit period to the Center. The center temperatures are plotted in Figure 2. It can be seen that the curves are almost identical.

Taste panel scores of the samples packed in plastic trays and of the samples packed in metal tins are shown in Figure 3. Here, again, the curves of both sets of samples are similar. A statistical analysis of the data showed no significant difference in the spoilage rates between the samples.

The taste panel observed that after only 2 days of storage the fillets had a slimy surface, were exceptionally salty in flavor, and had a rather mushy texture. This is not consistent with the panel's experience with flounder fillets of this age. It was further observed that ammonia odors became noticeable after 5 days of storage and increased through the rest of the test.

CONCLUSIONS

We could find no evidence that the plastic container used affected the cooling rate of the fillets or their temperature during iced storage. The cooling curves of the fish in both the plastic and metal containers were similar, and the final temperatures did not fluctuate.

Although we have no proof of any advantages or disadvantages resulting from the practice of brine packing, our experience and the comments of our expert taste panel leaves us with considerable doubt as to the desirability of its continued use by industry. In fact, we believe that further investigation of this practice should be made to determine its effect on the storage life of fillets.

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MFR PAPER 1062

Cysteine significantly reduces mercury content in sablefish without altering taste or texture.

Reduction of Mercury in Sablefish (*Anoplopoma fimbria*) and the Use of the Treated Flesh in Smoked Products

F. M. TEENY, ALICE S. HALL, and E. J. GAUGLITZ, JR.

ABSTRACT

A significant number of sablefish (Anoplopoma fimbria) *caught in certain areas of the west coast of North America have a mercury content in the flesh that exceeds the 0.5-parts per million guideline established by the United States Food and Drug Administration.*

This study was conducted to determine the feasibility of cysteine treatment to reduce the mercury content of sablefish and of subsequent utilization of the treated flesh in preparing hot-smoked products. This fish tissue was extracted with water containing cysteine hydrochloride in concentrations up to 1.0 percent. When comminuted flesh was extracted with 1.0 percent cysteine solutions, up to 80 percent of the mercury present initially in the flesh was recovered in the wash solutions. The amount of mercury that was removed from the flesh was related to: (a) pH of the cysteine-tissue mixture, (b) concentration of the cysteine solution, (c) volume of extracting solution, (d) number of extractions, (e) contact time, (f) processing temperature, and (g) tissue particulate size. Smoked products of good texture and flavor were prepared from the cysteine-treated flesh. Yields (dry basis) of 96, 81, and 73 percent were obtained as smoked products prepared from chunks, slices, and comminuted flesh, respectively.

INTRODUCTION

Trace metal analyses have shown that a significant number of sablefish (*Anoplopoma fimbria*) caught in certain areas off the west coast contained mercury that exceeded 0.5 parts per million (ppm). The United States Food and Drug Administration has established a guideline of 0.5 ppm of mercury as the maximum allowable level in fish (Edwards, 1971). Decreased fishing in those areas for sablefish places a heavier demand on the limited number of other species of low mercury content caught in those areas. The successful reduction of mercury from this fatty fish, and the utilization of the flesh in further processing into foods that are new or that would simulate those normally produced from this species could set a pattern to follow in dealing with other species with similar problems.

F. M. Teeny, Alice S. Hall, and E. J. Gauglitz, Jr. are members of the staff of the Pacific Fishery Products Technology Center, National Marine Fisheries Service, NOAA, Seattle, WA 98112.

Studies on the reduction of mercury from fish have shown that a significant percentage of the mercury present in the muscle was removed by chemical means. Spinelli et al. (1973) used cysteine to reduce the mercury content of halibut and fish protein concentrate by up to 50 percent; therefore, the possibility of using cysteine to reduce the mercury content from the muscle of sablefish was studied.

This report discusses the experimental use of cysteine in reducing the mercury content of sablefish and the utilization of the treated flesh in preparing organoleptically acceptable smoked products.

MATERIALS AND METHODS

Materials

The sablefish used in these experiments were caught commercially off the west coast of the United States and held in frozen storage at $-18°C$ for up to 6 months prior to use. The cysteine used was L-cysteine, HCl, H_2O. All percentages of cysteine are based on the weight of the monochloride, monohydrate form of the acid. All other chemicals were reagent grade.

Methods

Preparation of fish tissue and extraction procedures

The samples of fish used in the extraction procedures described below were either comminuted, sliced, or cut into chunks just before the extraction steps. Control samples were prepared in the same manner as the cysteine-treated samples except no cysteine was used in the extraction steps.

The comminuted flesh was prepared by passing chunks of flesh once

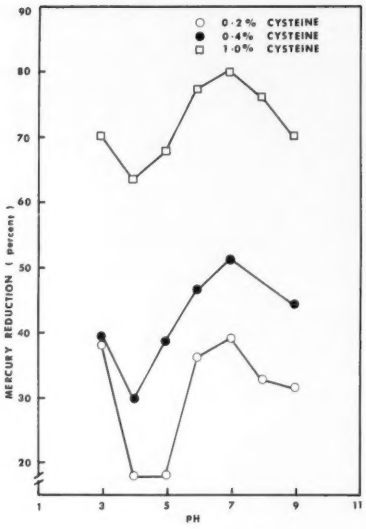

Figure 1.—Relation of total mercury reduction to pH of the comminuted flesh extracted with several levels of cysteine.

through a Hobart[1] grinder equipped with ¼-inch plate. The flesh was then mixed with aqueous cysteine solution at a ratio of one part flesh to two parts cysteine solution (w/v). The mixture was slowly stirred with a magnetic stirrer for the desired length of time. After stirring, the mixture was centrifuged for 15 minutes at 2,500 rpm. The solids were then resuspended in water containing no cysteine and the stirring and centrifugation repeated. The solids were finally resuspended in 0.1*M* NaCl and the stirring and centrifugation repeated once more.

The chunks (150-250 grams) of flesh were immersed in a cysteine solution in the same ratio as described for comminuted flesh. After holding the flesh in the solution for the desired length of time, the cysteine solution was decanted and flesh was washed under running tap water for 1 hour. The water was then drained, and 0.1*M* NaCl was added at a ratio of two parts of NaCl solution to one part flesh (v/w), recirculated for 1 hour, and drained.

The sliced flesh (approximately ¼-inch-thick sections) was treated in the same manner as the chunks.

After extraction, the washed comminuted flesh was mixed for 2 minutes in a blender (Osterizer Model B) with 2.5 percent NaCl and 0.2 percent sodium tripolyphosphate (STPP) in water. The flesh was then formed into blocks (approximately 200 grams each) for hot smoking.

The washed sliced flesh was formed into blocks of approximately 200 grams (cheesecloth and wire screens were used as molds for making the blocks) and soaked at a 2:1 ratio (weight of brine to fish) for ½ hour in 23 percent NaCl solution containing 0.2 percent STPP. The washed chunks of flesh were soaked in the concentrated brine in the same way.

Hot smoking

All samples were smoked for 7 hours in an electrically-heated smokehouse. During the final hour of processing, the samples were hot-smoked at a maximum smokehouse temperature of 100°C to obtain an internal flesh temperature of 75°C. Temperatures were measured by thermocouples imbedded in the flesh. After processing, the fish were cooled and weighed to determine yield.

Mercury analysis

Mercury was determined by the method of Malaiyandi and Barrette (1970) as modified by Munns[2]. Mercury reduction was based upon total mercury found in the flesh before and after processing.

Total solids and fat

Total solids and crude fat were determined on the raw and smoked products. For total solids, about 10-gram samples of prepared wet fish were weighed into flat bottom aluminum weighing dishes, about 5-cm diameter, heated for 16 hours at 100°C, cooled in a desiccator, and weighed. Crude fat was determined as described by the Association of Official Analytical Chemists (Horwitz, 1960) method.

Yield

Yield was determined for the raw and smoked products prepared from the treated flesh. Yields were determined on both dry (moisture-free) and wet basis for comparative purposes. Calculations were made as follows: Percent yield (dry basis) = dry weight of the flesh after either extraction or smoking divided by the dry weight of the raw flesh times 100. Percent yield (wet basis) for a smoked product = wet weight of the smoked product prepared from the extracted flesh divided by its wet weight prior to extraction times 100.

Sensory evaluation

The smoked products were coded and evaluated for quality by a panel of 10 experienced judges who compared differences in flavor, texture, and preference between the various test samples and two control samples. One of these control samples contained a sufficient amount of cysteine added just before smoking to ascertain the effect of a high level of added cysteine on the flavor. The other control sample was treated the same as the experimental samples but without cysteine in the extracting solution.

EXPERIMENTAL RESULTS

The feasibility of cysteine treatment to reduce the mercury content of sablefish was studied primarily with comminuted flesh in order to provide for the most effective contact of the cysteine solution with the flesh. Experimental variables included the pH of the extraction solution, the number of extractions, the concentration of cys-

[1] Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

[2] R. K. Munns, Food and Drug Administration, Denver, Colo., pers. commun.

teine in the extraction solution, the ratio of extraction solution to fish weight, contact time during extraction, temperature of the extraction mixture, and the effect of using water compared to 0.1*M* NaCl for the cysteine solution. Except in those tests in which pH and temperature were altered, the pH of the mixture was that of the fish-cysteine solution or pH 7, and the temperature was ambient.

Reduction of mercury

The effect of pH on the efficiency of cysteine to remove mercury from the comminuted flesh was determined. Extracting solutions of 0.2, 0.4, and 1.0 percent cysteine in water were mixed with the comminuted flesh and adjusted with either dilute hydrochloric acid or sodium hydroxide to pH values from 3 to 9. The results of these experiments (Figure 1) show that minimum reduction of mercury was obtained at pH 4 and maximum reduction at pH 7. Regardless of the cysteine concentration, there was an increase in total mercury reduction at pH 3 but a corresponding decrease in percent yield (Figure 2). The increase in total mercury reduction at pH 3 may be ascribed to the partial solubilization and subsequent loss in the myofibrillar portion of the muscle that binds mercury in fish flesh (Spinelli et al., 1973; Spinelli, Koury, and Miller, 1972).

Extractions of the comminuted flesh with various concentrations of cysteine up to 1.0 percent of fish weight, showed that total mercury removed increased with increasing cysteine concentration, but at a reduced rate. Approximately 40-50 percent of the mercury present in the flesh was removed with 0.2 percent cysteine, whereas only 60-80 percent of the mercury present in the flesh was removed with 1.0 percent cysteine (Figure 3). Two successive extractions with fresh solution of the same cysteine concentration removed only about 10 percent more mercury than with a single extraction of a solution of twice the concentration (Table 1).

Other experiments were conducted wherein the ratio of the cysteine to fish was kept constant (0.2 gram cysteine to 100 grams fish), but the volume in which the cysteine was dissolved ranged between 50 and 500 ml. Results showed that cysteine was most effective (Table 2) where the cysteine solution was most concentrated.

The effect of contact time between the flesh and the cysteine extracting solution upon mercury reduction was determined. With comminuted flesh, extractions were performed in which the contact time between flesh and solution varied from 2 to 60 minutes. Results (Figure 4) show no increase in mercury reduction beyond 2 minutes. This indicates the rapidity of mercury displacement from the flesh in contact with the cysteine solution.

Comminuted flesh was extracted with various concentrations of cysteine solutions at 2°C and at 20°C. The results (Table 3) show that for any given concentration of cysteine, higher mercury reduction and lower fish weight (dry basis) and fat were

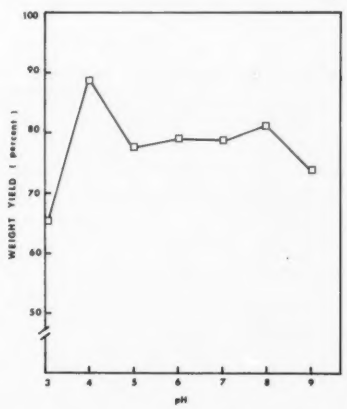

Figure 2.—Relation of total weight recovered to the pH of the comminuted flesh-cysteine mixture.

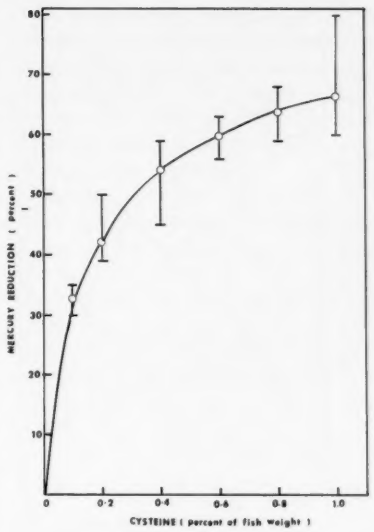

Figure 3.—Relation of mercury reduction to cysteine concentration.

Table 1.—Relation of mercury reduction to number of extractions with cysteine solution of several concentrations.

Number of extractions	Cysteine concentration	Total mercury reduction
	Percent	*Percent*
1	0	6.0
2	0	13.0
1	.2	42.0
2	.2	67.3
1	.4	51.9
2	.4	71.2
1	.8	65.3

obtained at 20°C than at 2°C. The overall lower weight yield at 20°C could be ascribed to the greater losses of fat. In these experiments the fat accounted for 57 percent of the dry weight.

The following variables were studied and found to be ineffective in improving the effectiveness of cysteine to remove mercury from sablefish: Heat denaturation prior to extraction, pressure (up to 2,000 pounds per square inch), recirculation of the cysteine solution, and preextracting the flesh with water, 0.1*M* NaCl and EDTA (tetra sodium or calcium disodium). Other additives

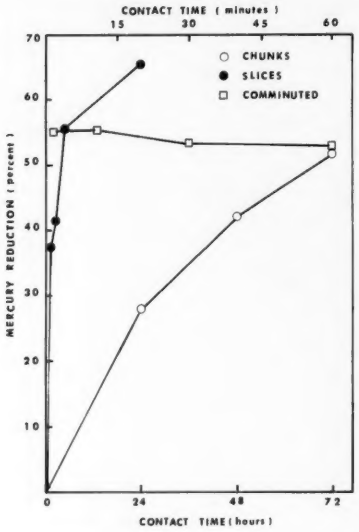

Figure 4.—Relation of mercury reduction to contact time between chunks, slices, and comminuted flesh of sablefish and the extracting cysteine solution (contact time is the hours for chunks and slices and minutes for comminuted flesh).

tried including citric acid, thiourea, nonfat dry milk solids, and fresh whole milk were ineffective, either alone or in conjunction with cysteine. Extracting the flesh with cysteine in an atmosphere of nitrogen and carbon dioxide did not improve the effectiveness of cysteine to remove mercury from the flesh.

Mercury Distribution in the Flesh Prior to and After Cysteine Extraction

Extraction of the comminuted flesh with 1.0 percent cysteine followed by one water and one NaCl wash resulted in mercury reduction of 60 to 80 percent. In a typical experiment where 100 grams of raw flesh contained 100 μg mercury, we found that after extraction the washed flesh contained about 23 μg mercury or 23 percent of that originally present in the flesh. The cysteine, water, and NaCl washes contained 45, 15, and 17 percent of the total mercury, respectively. Mercury appeared to be associated only with the myofibrillar portion of the flesh (Spinelli et al., 1973). The apparent loss of mercury from controls (Table 3) can be attributed to losses of very fine protein particles during the washing process.

Table 2.—Effect of volume of the cysteine solution on mercury reduction.

Cysteine (percent of fish weight)	Ratio of fish weight to volume of solution	Total mercury reduction	Mercury (ppm dry basis)	Total weight yield (dry basis)
		Percent		*Percent*
0	0	—	3.08	100.0
0	1:2	5.5	3.58	80.3
0.2	1:½	44.3	2.03	84.5
0.2	1:1	39.9	2.16	85.6
0.2	1:2½	37.7	2.31	83.0
0.2	1:5	36.5	2.35	83.2

Removal of Organoleptically Detectable Cysteine

The level of cysteine in the smoked products that could be detected organoleptically was determined by adding various amounts of cysteine to the comminuted, washed flesh prior to smoking and evaluating the smoked products for cysteine flavors. Results showed no detectable cysteine off-flavors at the 0.01 percent level, whereas 30 percent of the panel members detected cysteine at the 0.05 percent level. Thus we estimate that the cysteine remaining in the tissue after extraction to be less than 5 percent of the cysteine added for mercury reduction purposes.

Tests with Slices and Chunks

Two variables, contact time with the extraction solution and a method of increasing surface contact of chunks with the solution, were evaluated to demonstrate the feasibility of using intact slices or chunks of sablefish as compared to the process of comminution, treatment, and preparation of a reformed block. The limited tests showed that extraction of mercury from sablefish flesh was much less efficient when either slices or chunks were used. With slices and chunks, for example, the contact time between the cysteine solution and flesh varied from 1 to 24 hours, and 1 to 3 days, respectively (Figure 4). The data show that in

Table 3.—Effect of processing temperature upon mercury reduction and yield from comminuted sablefish treated with various levels of cysteine.

Cysteine concentration	Processing temperature	Total weight yield	Total fat yield	Total mercury reduction
Percent of fish weight	°C	*Percent*	*Percent*	*Percent*
0 (Untreated control)	2	100.0	100.0	—
	20	100.0	100.0	—
0 (Treated control)	2	87.3	92.5	8.3
	20	71.1	65.8	9.4
0.2	2	85.7	93.8	31.1
0.2	20	75.2	69.2	39.6
0.4	2	85.8	93.8	34.1
0.4	20	65.5	61.0	51.2
1.0	2	88.4	97.3	46.7
1.0	20	72.5	63.0	68.0

1.0 percent cysteine solution it required about 4 hours for slices and 3 days for chunks to lose approximately 50 percent of the mercury originally present in the flesh. Extracting the flesh with cysteine in 0.1*M* NaCl showed no advantage over cysteine in water.

Increasing the surface area of the chunks of flesh in contact with the cysteine solution by perforation (about 25 holes to the square inch) resulted in increased reduction of approximately 10 percent.

Yield of Smoked Products

The extraction operation resulted in yields (dry basis) up to 70, 80, and 95 percent as raw washed flesh prepared from comminuted flesh and flesh cut into slices and chunks, respectively. Losses can be attributed mainly to losses in fat and sarcoplasmic proteins. Results from a typical experiment on comminuted flesh showed that 70 percent of the dry weight of the flesh was obtained as washed flesh, 25 percent as fat floating on top of the extracting solutions, and the rest consisting mainly of the soluble sarcoplasmic proteins. The fat floating on top of the extracting solutions could be recovered and added back to the washed flesh.

Yields (dry basis) as smoked products, varied with the type of flesh used. Yields of about 96, 81, and 73 percent were obtained from chunks, slices, and comminuted flesh respectively. No drip was observed from blocks made from the comminuted flesh, but some drip was observed from chunks and slices. The salt compensated for some of the moisture lost during the smoking process.

The yield of the smoked product on wet basis was 70 percent for chunks and 68 percent for blocks made from sliced flesh. Inasmuch as the smoked products prepared from the comminuted flesh were prepared by blending the washed flesh with a definite amount of salt dissolved in water, recovery was on the dry-weight basis described earlier.

Table 4.—Sensory evaluation of smoked sablefish prepared from sliced flesh treated with various levels of cysteine.

	Flavor[1]	Texture[1]	Preference[2]
Control (no cysteine treatment)	3.8	4.2	6.6
Extracted with 0.2% cysteine	3.9	4.1	6.9
Extracted with 1.0% cysteine	3.6	4.0	6.4

[1] 5-point scale: 5, very good; 1, poor.
[2] 9-point hedonic scale: 9, like extremely; 5, neither like nor dislike; 1, dislike extremely.

Sensory Evaluation of the Finished Smoked Products

Sensory evaluation of the finished smoked products prepared from the cysteine-treated flesh showed the samples to have a delicate smoked flavor typical of the smoked sablefish. Blocks made from comminuted flesh had moist spreadable texture. The blocks made from slices had flaky and moist texture such as found in the chunks, but the flakes were of slightly smaller size (due to slicing). Typical results (Table 4) showed no significant differences in flavor, texture, or preference between the cysteine-treated samples and the untreated controls. Similar results were obtained from the evaluation of treated and smoked chunks.

CONCLUSION

This work demonstrated that the mercury content of sablefish exceeding the current 0.5 ppm guideline can be significantly reduced using a cysteine treatment. Mercury reduction was related to (a) pH, (b) cysteine concentration, (c) volume of the cysteine solution, (d) contact time between flesh and solution, (e) temperature of extraction, (f) particulate size, and (g) number of extractions. Reduction of mercury by means of a 1.0 percent solution of cysteine was significantly more efficient with comminuted flesh than with slices or chunks.

Smoked products prepared in a conventional smoking process from the cysteine-treated flesh had good flavor and texture as compared to the controls (smoked products prepared in a similar way but without cysteine). The smoked products, as chunks or blocks prepared from slices and comminuted flesh, have yields (dry basis) of 96, 81, and 73 percent respectively, based on original weight of raw flesh.

ACKNOWLEDGMENTS

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MFR PAPER 1063

Northern Hemisphere fish might tap the rich krill stocks of the Southern Ocean.

Salmon—Future Harvest from the Antarctic Ocean?

TIMOTHY JOYNER, CONRAD V. W. MAHNKEN, and ROBERT C. CLARK, JR.

INTRODUCTION

The ocean surrounding the Antarctic continent is an enormous reservoir of protein. A world increasingly beset with food shortages cannot for long afford to let it remain unharvested. The key to this untapped bounty is a little red crustacean, *Euphausia superba,* that looks like a small shrimp and is commonly called krill. A product of the immense fertility of the Southern Ocean, its food supply is assured by lush pastures of single-celled marine plants in the fertile zone of circumpolar upwelling (Figure 1). Second in the short Antarctic food chain, krill underlies the remaining links made up of squid, penguins, sea birds, seals, and whales.

Intensive study by Soviet scientists of data obtained by fishery research vessels, operating in Antarctic waters since the early 1960's, has produced evidence that exploitation of krill resources could at least double the present global production of aquatic animals. In late 1973, scientists of the All-Union Institute of Marine Fisheries and Oceanography (VNIRO) estimated the potential annual catch of krill to be 100 million tons.

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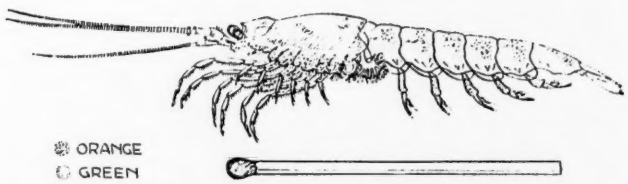


Krill, a small crustacean of the species *Euphausia superba,* forms a major part of the food supply of the whale population of the Southern Ocean.

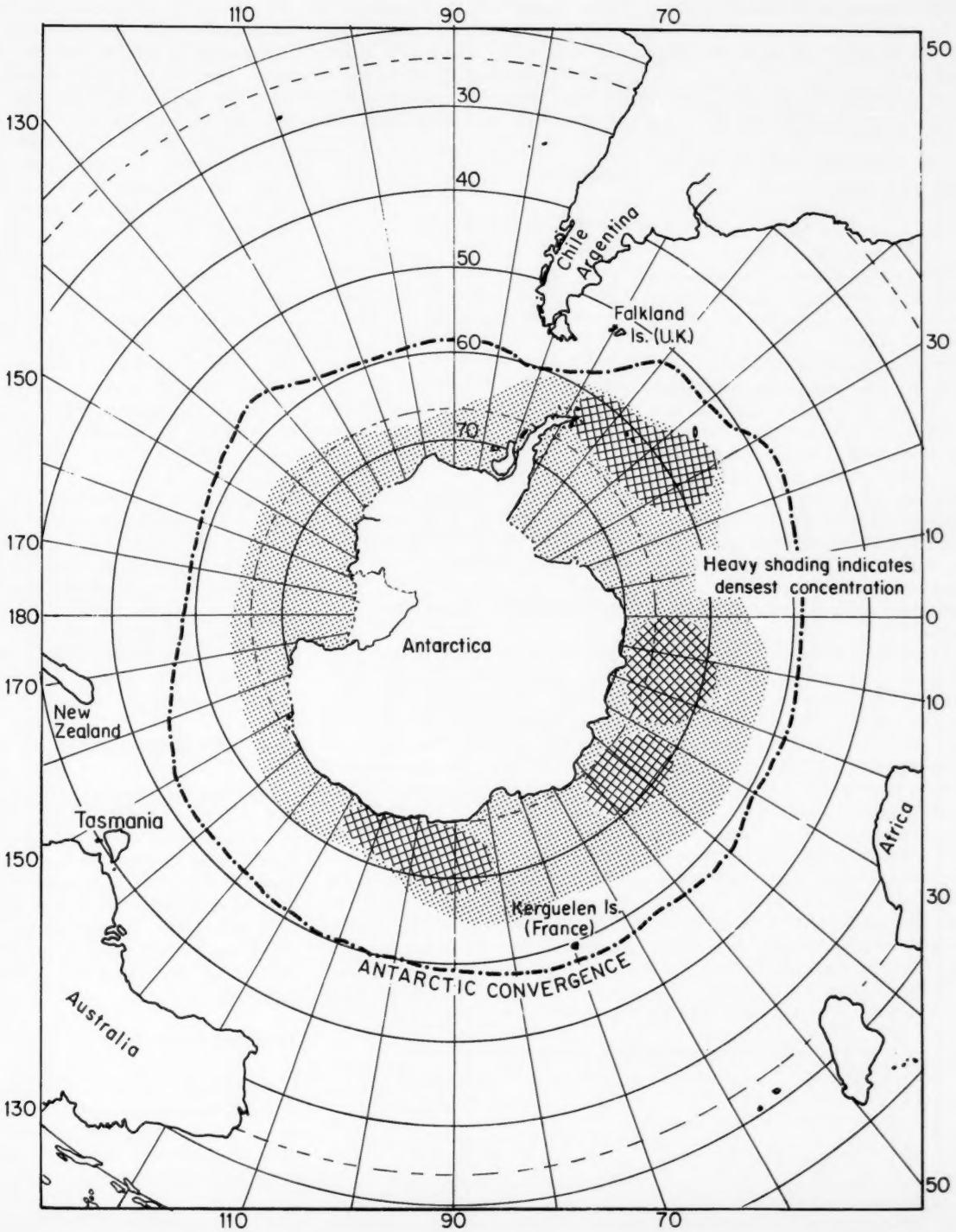
This enormous abundance of krill has been a source of fascination to fishing and food interests throughout the world. The Soviets and the Japanese are developing techniques for processing krill into a palatable food product. Harvesting it, though, is a difficult and expensive proposition, requiring large vessels operating for extended periods far from their home ports. With the skyrocketing prices of petroleum fuels brought on by the world-wide energy crisis, the prospects for a profitable high seas krill fishery now seem dim indeed.

PROSPECTS FOR AN ALTERNATIVE HARVEST

Is there another way of tapping this vast Antarctic reservoir of protein? Since we cannot yet harvest krill economically by ourselves, ought we not to try to get help from some other creature better equipped by nature to do it? To a limited extent baleen whales once did this. However, as they breed slowly and produce few offspring, the stocks were so decimated by intensive whale fishing that they are now threatened with extinction. Since none of the other links of the short Antarctic food chain that depend on krill could withstand intensive harvesting either, it would seem logical to examine the prospects for introduction of species from the great diversity of arctic and subarctic fauna. Success in introducing exotic species to Antarctic waters would be favored by:

(1) *Adaptability to life at sea and a propensity to feed on marine plankton.*—Except for the barren, ice-covered Antarctic continent, there is little land in the Southern Ocean.

Figure 1.—Krill resources in the Southern Ocean—summer distribution.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Falkland Is. (U.K.)
Heavy shading indicates densest concentration
Antarctica
New Zealand
Tasmania
Australia
Africa
Kerguelen Is. (France)
ANTARCTIC CONVERGENCE

Only creatures well adapted to ocean life and able to feed on plankton would be able to thrive on the abundant krill.

(2) *Adaptability to cold water.*—The greatest abundance of krill occurs south of the Antarctic Convergence where water temperatures at the surface range from 5° to 0°C.

(3) *High fecundity.*—The broad, circumpolar distribution of krill in the waters south of the Antarctic Convergence would encourage wide dispersion of species feeding on them. Prolific species producing large numbers of offspring from relatively few mating encounters would help insure growth of a transplanted population.

(4) *Protection for eggs and larvae.*—Large populations of potential predators such as sea birds and plankton-straining marine mammals would threaten the survival of planktonic juvenile stages of transplanted stocks. Species that afford some protection for their vulnerable offspring would have an important advantage in the struggle to establish a self-reproducing population.

(5) *A life cycle matching the period of ocean circulation.*—The west wind drives the surface waters of the Southern Ocean eastward at an average speed of 1 knot, producing a global circuit at lat. 50°S in 690 days. Species feeding randomly in the zone of the Antarctic Convergence, if they matured in a similar interval or multiple thereof, would find themselves close to the place where they began their lives. This would be an advantage for many species, as breeding patterns could be adapted to a single set of environmental conditions.

Beyond having the biological ability to adapt to the new environment, exotic species to be introduced to Antarctic seas should be easy to harvest and to process into a readily marketable product. Of all the species we have considered, salmon are by far the most promising candidates.

SALMON

General Characteristics

The six Pacific species, genus *Oncorhynchus*, and the one Atlantic species, *Salmo salar*, are adapted to cold subarctic waters. Spawning in fresh water, they migrate to sea as juveniles. There they range over thousands of miles of ocean to feed and grow fat on planktonic crustaceans and small fish. Several years later as adults, they return to the river where they were spawned to complete the cycle. The flesh is nutritious, highly palatable, and commands premium market prices wherever it is sold.

Environmental Preference

In both Pacific and Atlantic Oceans, salmon range from the arctic ice to the subarctic-subtropical boundary and spawn in streams on both sides of the two oceans. The cool, wet marine climates of northwestern North America and Europe produce particularly favorable conditions for salmon. In these climatic zones the temperature of the groundwater that feeds the streams in which salmon spawn generally ranges from 3° to 10°C. Winters are mild and summers are cool so that the streams, rivers, and lakes seldom freeze solid nor rise above 20°C, a range which spans the limits of temperature tolerable for salmon of all species. Optimum temperatures for the development and growth of salmon vary between these extremes according to species and race but are generally close to the average temperature of groundwater in the center of the spawning range of the stock being considered.

On the high seas, the temperature preferences of salmon are harder to determine. A range from 2° to 12°C for Pacific salmon was inferred from observations of surface water temperatures taken concurrently with gill net sets from fishery research vessels operating in the North Pacific (Table 1). The order of preferred temperatures for the different species is: sockeye, *O. nerka*, and chum, *O. keta* < pink, *O. gorbuscha* < chinook, *O. tshawytscha* < coho, *O. kisutch*, and cherry, *O. masou*.

The stage of development at which salmon can effect the change from fresh to salt water also varies with species and race, ranging from newly hatched fry to large fingerlings several years old. For the different species the size at which salt water can be tolerated generally follows the order: chum and pink < sockeye < chinook < coho < cherry and Atlantic.

Table 1.—Tolerable and preferred sea-surface temperature for Pacific salmon.

Species	Tolerable range °C	Preferred range °C	Reference months for preferred range
Sockeye	1-15	2,3-9	May, September
Chum	1-15	2,3-11	May, September
Pink	3-15	4-11	May, June
Coho	5-15	7-12	May, June, July
Chinook	2-13	7-10	July, August, September
Cherry (masou)	5-15	7-12	March, April, May

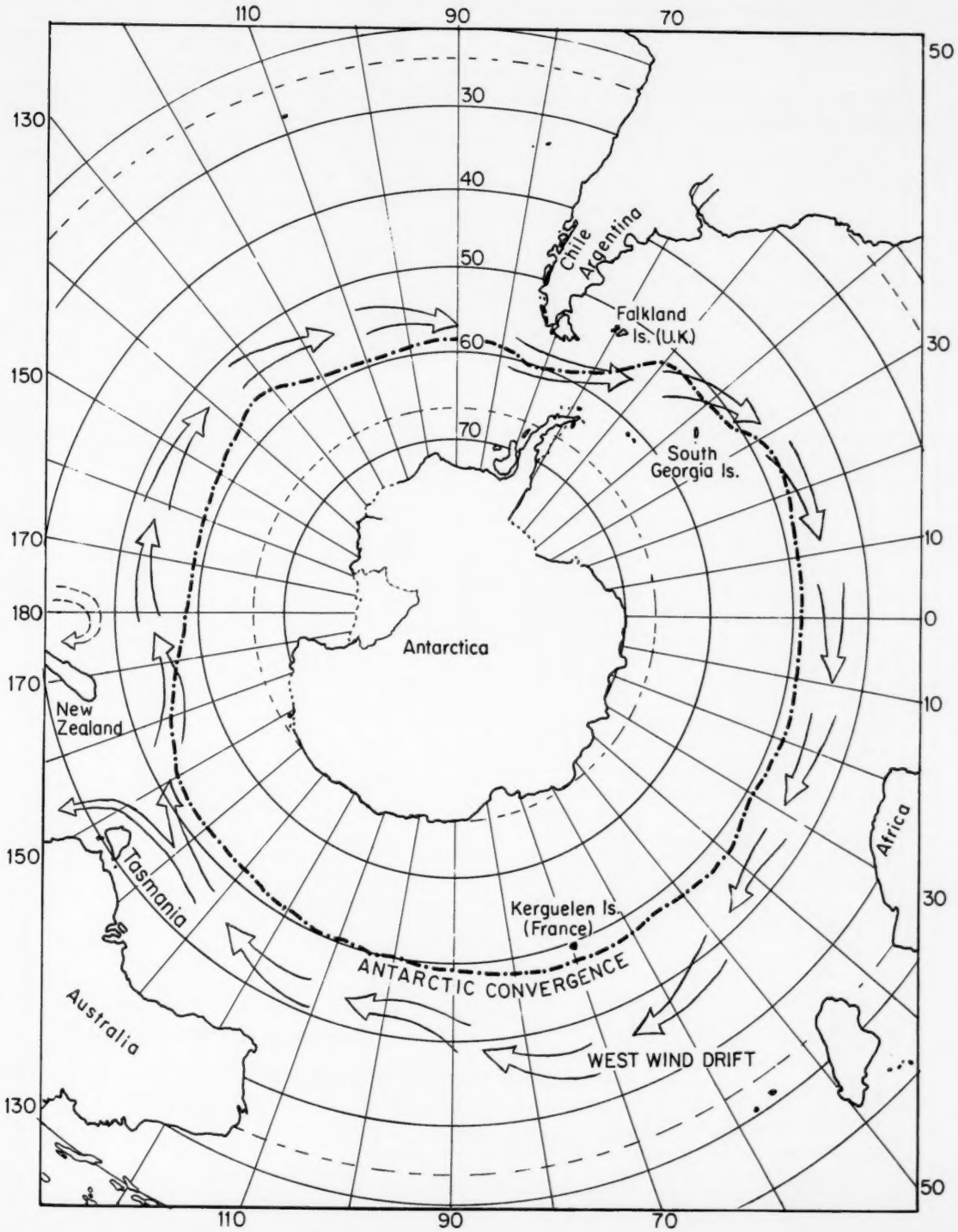
THE SOUTHERN OCEAN

The seas surrounding Antarctica gird the earth unbroken by any significant land mass. No longer regarded merely as the confluence of the Pacific, Atlantic, and Indian Oceans, they are now recognized as a distinct body of water which is coming to be called the Southern Ocean by geographers and oceanographers around the world.

The West Wind Drift

Bounded on the north by the Subtropical Convergence near lat. 40° S and on the south by the ice-covered mass of Antarctica, strong westerly winds drive the waters of the Southern

Figure 2.—The West Wind Drift.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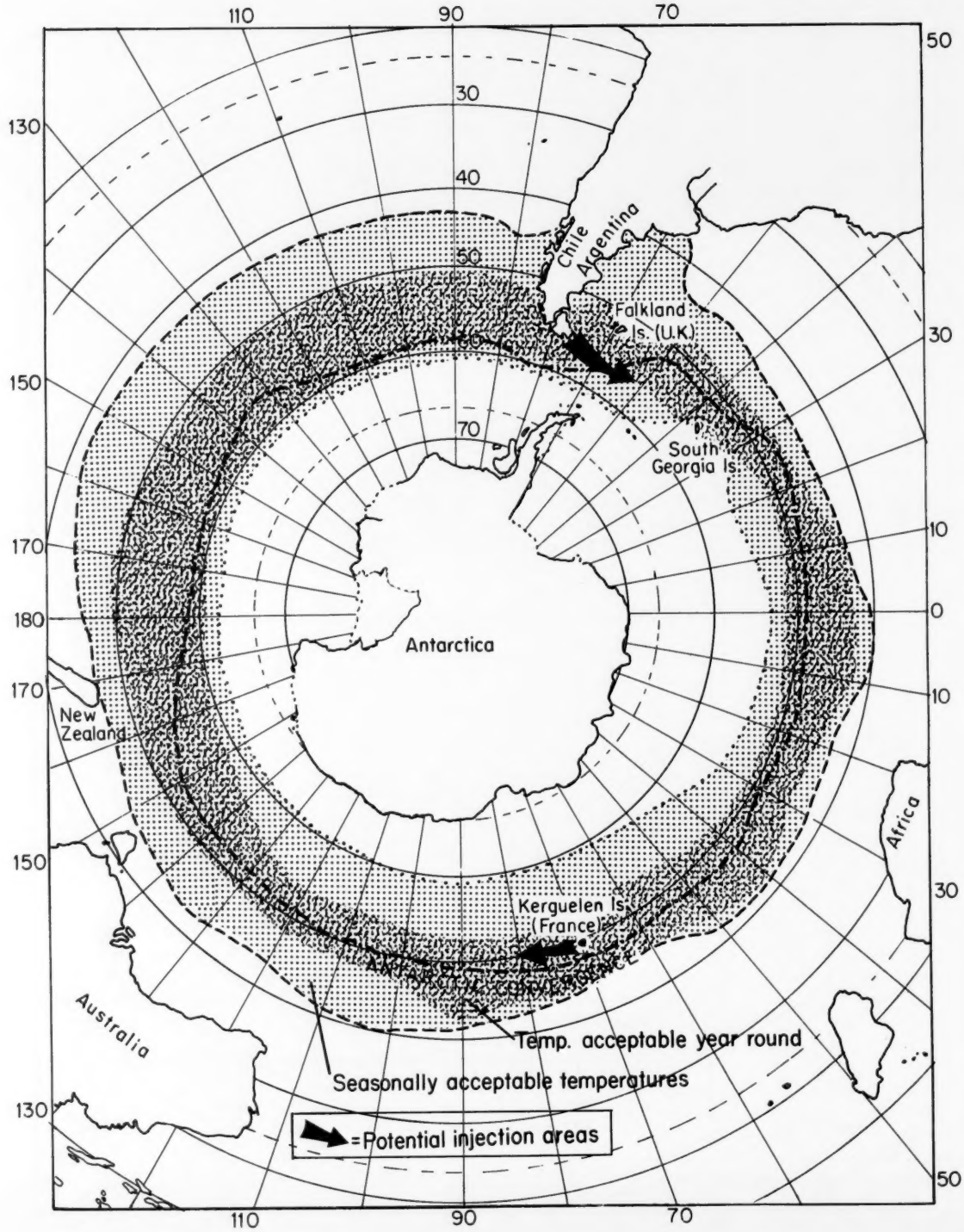
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South Georgia Is.
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Antarctica
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New Zealand
Africa
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Kerguelen Is. (France)
Australia
Temp. acceptable year round
Seasonally acceptable temperatures
130
=Potential injection areas
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Ocean continuously eastward in a current known as the West Wind Drift (Figure 2). Upwelling inside the Antarctic Convergence brings to the surface nutrients dissolved in deeper waters from decayed, sinking bodies of marine organisms and from finely ground rock powder dropped by melting glacial ice. These nutrients are carried northward to the region of the Convergence, in the vicinity of lat. 50° S, by cold surface waters flowing outward from Antarctica.

Land Masses

There is little penetration by land into the Southern Ocean. Tasmania, New Zealand's South Island, and the southern end of South America are the only significant land masses impinging upon it. There are also the Falkland, South Georgia, and Kerguelen Island groups and a few minor Antarctic islands.

Tasmania and South Island lie at the northern extremity of the Southern Ocean where the major divergence of the West Wind Drift splits off and heads northward through the Tasman Sea to merge with the warm waters of the Australian Current. On the eastern side of South Island, over the New Zealand Plateau and the Chatham Rise, a weak, clockwise gyre sends water northward along the coast to the Subtropical Convergence. Salmon migrating to sea from Tasmania or the west coast of New Zealand would have to swim great distances against the current to reach the Antarctic Convergence. Those drifting north with the current would probably perish as they were carried into the subtropics. Salmon entering the sea on the east side of New Zealand would tend to circle in the gyre over the sea-bottom plateau and probably would not find suitable feed as readily as they would have if they had gotten into the krill of the West Wind Drift. Since the gyre is small, they would be carried rather quickly back to the coast of South Island and would probably tend to enter their home streams as relatively small fish. This may well be the case with the residual stocks from the Quinnat (chinook) salmon transplanted to the South Island in the early years of this century.

The southern extremities of Argentina and Chile and the Kerguelen Islands lie close to the Antarctic Convergence and krill-rich waters. In both areas a cool, wet Marine West Coast Climate prevails. Combined with the deeply indented coastlines rising to hilly or mountainous terrain—which typifies these two regions—environments are produced that are strikingly similar to those of southeastern Alaska and the Aleutian Islands, which contain some excellent salmon spawning streams. In Chile since 1905, a number of attempts have been made to establish Pacific salmon in the streams of the lake district lying between lat. 38° and 42°S. These attempts have not met with much success. Chilean biologists, convinced that the environment in their country should favor the introduction of salmon, ascribe these failures to the small numbers of ova that were involved, poor handling, and predation on the few surviving fry by brown and rainbow trout. We would like to point out an oceanographic feature which weighs against the survival of sea-going salmon introduced into that region. In those latitudes, the dominant oceanographic feature is the northward-moving Humboldt Current. Rich in feed and cooled by the upwelling of deep water along the coast, it would be an attractive lure to sea-going salmon. Moving randomly as they fed on the abundant small sea life, they would be carried north and west by the current until it merged with the warm waters of the South Equatorial Current. Such a journey would be fatal for most salmon. Only salmon that have a propensity for remaining close inshore during their life at sea could become established in south-central Chile. Selected races of coho and cherry salmon would be the best choices for this region.

Figure 3.—Salmon environment in the Southern Ocean.

SEEDING THE SOUTHERN OCEAN WITH SALMON

From the foregoing it can be deduced that the waters of the West Wind Drift provide the Southern Hemisphere's most favorable environment for the oceanic part of the life cycle of most salmon. In the zone of upwelling inside the Antarctic Convergence where great concentrations of krill are found, water temperatures range from about 7° to about 2°C. Such a regime would favor the more northerly distributed stocks of chum, sockeye, and pink salmon as candidates for transplanting to the Antarctic (Figure 3). The stage of development at which different species of salmon can enter salt water is also an important consideration for selecting appropriate stocks for transplanting. The earlier young salmon are released to go to sea, the lower is the cost of operating hatcheries. Chum and pink salmon fry can tolerate salt water as soon as the yolk sac is absorbed. If released at this stage, no artificial feeding is necessary and hatchery costs are minimal.

Although there is little land in the Southern Ocean for providing the freshwater environment essential for the early life of salmon, the topography and climate of the southern tip of South America closely parallel those of southeastern Alaska. The mean annual air and sea-surface temperatures fall between 7° and 8°C. Starting from a coast lying directly alongside the main body of the West Wind Drift as it funnels through the constriction of Drake Passage, salmon migrating to sea from streams in southern Argentina and Chile should have little difficulty in finding the krill inside the Antarctic Convergence. Assuming that they would move randomly as they fed on krill, they would be carried eastward in the current at an average speed of 1

knot. At lat. 50°S they would complete one circuit in about 2 years and two circuits in 4 years. Or, they might choose to stay in the rich krill concentrations of the Scotia Sea to the southeast of Cape Horn. In either event, the mingling of freshwater runoff from the Andes Mountains with the waters of the West Wind Drift should lead them readily back to the coastal area where they were spawned.

The Kerguelen Islands in the Indian Ocean sector, with mean annual air and sea-surface temperatures close to 5°C, lying directly in the zone of the Antarctic Convergence, could also possibly serve as a land base for transplanting salmon into the Southern Ocean.

Introduction of salmon on a scale sufficient to generate a significant fishery in the Southern Hemisphere will have to confront the basic problem of initially injecting large numbers of suitably adapted stocks from a strategically located land base into the West Wind Drift close to the Antarctic Convergence. The initial injection should be sufficiently massive that enough would survive the difficulties of inverted seasons and an alien geography to produce a growing population with each successive cycle. Stocks of chum and possibly sockeye or pink salmon adapted to Arctic waters released from southern Chile and Argentina or the Kerguelen Islands, should move across the temperature gradient until they passed the 5°C isotherm just inside the Antarctic Convergence. There they should find plenty of krill.

Soviet experiences with transplanting pink salmon to the Murmansk area of the European Arctic from Sakhalin Island in the Pacific Ocean provide us with some valuable insights regarding the problem of large-scale transplants. From 1956 to 1961, transfers of from 4 to 46 million roe were made between fish culture stations in Sakhalin and Murmansk. Ocean survival was good and the returns peaked in 1960 when 300,000 adult pink salmon entered streams in the Murmansk area, with smaller numbers showing up along the coasts of Norway, Iceland, and Great Britain. The runs subsequently dwindled, as the roe from the returning spawners perished during incubation, the winters being considerably colder around Murmansk than on Sakhalin, home of the parent stock. These Soviet experiences suggest strongly that plans for mass transplants to the Southern Ocean should involve initial releases of millions of fish. There should also be provisions for recapture of a significant fraction of the homing migration to take eggs for artificial incubation. It would be too risky to rely on natural stream spawning to maintain the transplanted population.

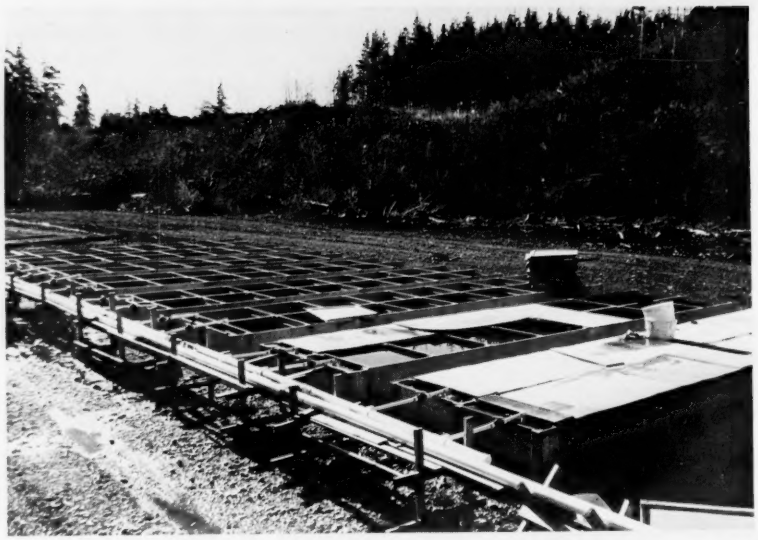

Figure 4.—Low-cost gravel incubators, Quinault Indian Reservation, Washington.

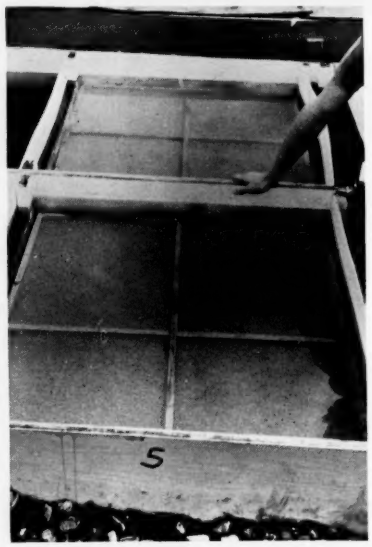

Figure 5.—Detail—gravel incubator.

In our opinion, a hatchery and suitable fish traps should be built on the southern coast of Chile or Argentina. As many eyed eggs of Arctic stocks of chum salmon as could be collected would be shipped to the hatchery for incubation and released as swim-up fry. The hatchery should be as close to the sea as possible so that the fry on their way downstream to the ocean would not be spotted easily by birds. The hatchery would consist of low-cost gravel type incubators (Figures 4, 5). Feeding would not be necessary as the fry would be released as soon as the yolk sacs were absorbed. Returning adults would be collected in Alaska-type salmon traps

Figure 6.—Aerial view of floating salmon trap, Alaska.

Figure 7.—Closeup view of floating salmon trap, Alaska. (Photograph courtesy of Fisheries Research Institute, University of Washington.)

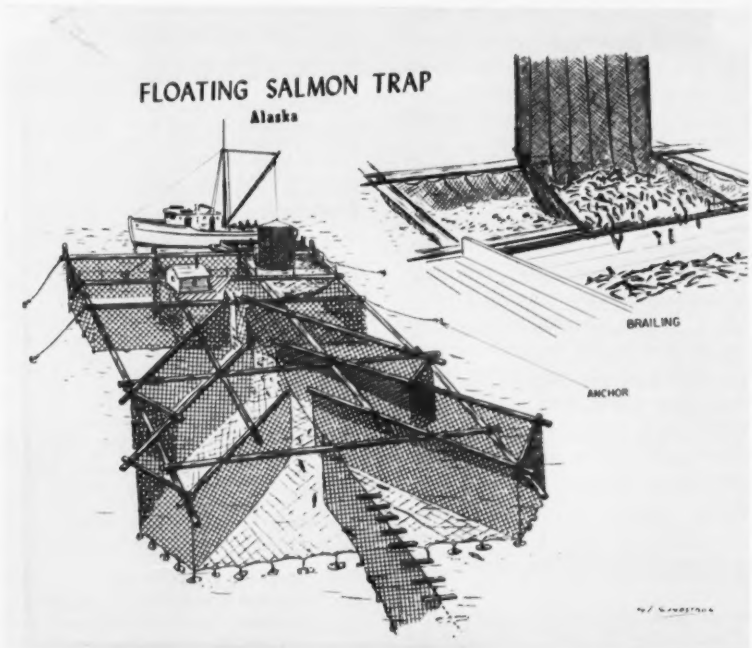

Figure 8.—Detail, floating salmon trap, Alaska. From Sundstrom, Gustaf T., 1957, Commercial Fishing Vessels and Gear. U.S. Fish and Wildlife Service Circular 48.

Icebergs of the Southern Ocean. (Photograph courtesy of Wm. H. Curtsinger, National Science Foundation.)

of proven efficiency (Figures 6-8). Eggs would be shipped by air in refrigerated containers for four successive years. By then the probable success or failure of the experiment should be discernible.

If successful, the experiment would point the way to a low cost hatchery-trap system for harvesting Antarctic krill resources as nutritious, highly marketable salmon. The efficiency and consequent low energy cost of such a system should make it not only an ecologically desirable alternative to the whale fishery, which is threatening these rare and unique animals with extinction, but also an economically viable alternative to a potentially expensive high-seas krill fishery.

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MFR PAPER 1064

A trash fish may become a food fish if a way can be found to reduce levels of . . .

Ocean Pout Parasites

DANIEL J. SHEEHY, MICHAEL P. SISSENWINE, and SAUL B. SAILA

ABSTRACT

Approximately 600 ocean pout, Macrozoarces americanus, *were collected from two locations in Rhode Island Sound. Each specimen was skinned and filleted. The fillets were examined for visual lesions resulting from parasitic infections by the microsporidian,* Plistophora macrozoarcidis.

Of the specimens examined, 29 percent had parasitic lesions, while 7.5 percent had more than a single lesion. The incidence of infection was shown to be significantly correlated with the age, length, and weight of the specimens, although most of the variability in the infection rate remains unexplained. No statistically significant differences in the rate of infection between sexes or areas sampled were determined when the data were adjusted for variations in length. The incidence of lesions in the anterior ventral portion of the fillets was significantly higher than elsewhere, suggesting the possibility of removing the highly infected portions of the fillets as an inexpensive means of reducing the level of infection of the resulting product.

INTRODUCTION

Ocean pout (*Macrozoarces americanus*) are primarily available in Rhode Island waters during January through May at a depth of 30 to 60 meters. In 1969 less than a metric ton (MT) of ocean pout was landed commercially in the Northeast for human consumption. Most of the current catch is processed as trash fish with a market value of less than $40 per MT. This is in contrast to about 2,035 MT in 1944 with a market value of about $247,000.

Ocean pout were marketed during World War II (1943-44). However, the incidence of parasitic lesions in the fillets and an embargo by some public health agencies caused a rapid decline in the human consumption of ocean pout and its eventual relegation to a trash fishery. A comprehensive study by Olsen and Merriman in 1946 indicated that the barriers to continued marketing of fillets for human consumption were technological rather than biological. Overcoming these barriers depends on the development of methods of efficient handling and removal of infections as well as proper preservation of fillets in the frozen state.

The protozoan parasite responsible for the lesions was identified by Nigrelli (1946) as the microsporidian, *Plistophora macrozoarcidis*. While this parasite does cause visible lesions on the fillets, there has been no demonstration of transmittance of illness to mammals as a result of the consumption of infected fish (Sandholzer et al., 1945).

Present conditions of declining coastal fish stocks, competition with foreign vessels offshore, and the increasing cost of meat products emphasize the need for a rational and more efficient utilization of available marine resources. Today, more than 25 years after Olsen and Merriman's (1946) study, interest has again been expressed in ocean pout and a reevaluation of its potential as a commercially valuable species. This paper is concerned with the present incidence of microsporidian parasites in ocean pout from Rhode Island waters.

METHODS AND MATERIALS

Three samples of ocean pout were collected from Rhode Island Sound (Figure 1) on 23 and 28 February and 25 March 1972. Although three distinct samples were actually collected, two were within close proximity of each other and therefore will be referred to collectively as from location A. This location is usually called the "east edge of the Southwest Ground." The third site will be referred to as location B and is usually called the "Torpedo Range" (Figure 1). Samples were taken at a depth of 20 to 40 meters using a standard 71-91 yankee otter trawl with 3.75 cm codend mesh size. Approximately 600 specimens were collected.

Length and weight measurements were made for each fish, the sex determined, and the otoliths removed and stored dry. An index of condition was calculated for each fish and was defined as follows: condition $= 100\ (\text{weight})\ (\text{length})^3$ (Fessler and Wagner, 1969). The fish were then filleted and skinned. The fillets were examined for visible parasite lesions by candling. Fillets were divided longitudinally and vertically into four

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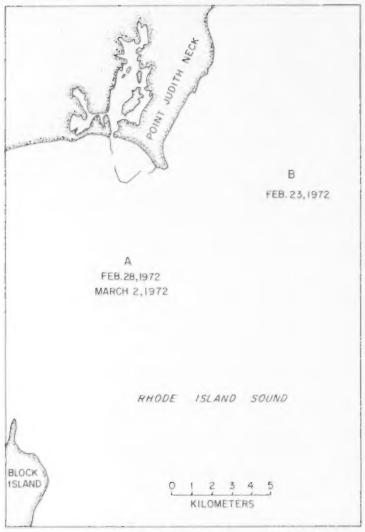

Figure 1.—Sampling locations within Rhode Island Sound.

quadrats of equal area and the number of lesions in each quadrat counted (Figure 2). Candling was accomplished using a simple 60 cm × 25 cm × 25 cm candling box constructed of plywood and translucent white plastic. Three 100 watt lightbulbs with aluminum foil lining as a reflector served as the light source. This device provided a simple but effective method of locating lesions in the fillets.

Otolith Analysis

Otoliths were exposed by a transverse incision approximately midway between the eye and the operculum and extending to the upper jaw. The otoliths could then be removed from their pockets just lateral and ventral to the brain. Tissue adhering to the otoliths was easily removed by gently rubbing them between the thumb and forefinger.

Several methods of cleaning otoliths for observation were evaluated and the technique described by Jensen (1970), using a few drops of 50 percent glycerine and 50 percent water, was adopted as most satisfactory. This method provided clearer contrast between the light and dark bands than either the dry method of Olsen and Merriman (1946), the 100 percent glycerine technique of Clemens and Clemens (1921), or the burning method of Christensen (1964). The technique of treating in glycerine described by Lawler and McRae (1961) was utilized with success on some of the denser and more difficult to read otoliths.

The immersed otoliths were viewed against a black background on both their lateral and medial surfaces at 10 × using a binocular microscope and reflected light. In general the lateral (or convex) side provided the most distinct pattern of opaque and hyaline bands. After aging, the slide was transferred to a scale enlarger and the longest length through the center, the width, and the length to the otolith notch were determined to the nearest centimeter.

Age estimation from the otoliths was based on the general criteria utilized by Clemens and Clemens (1921) and Olsen and Merriman (1946). The central core (slightly hyaline in clear otoliths) was considered as representing the conception of the fish and the surrounding opaque zone its embryonic growth. The first hyaline band was interpreted as the winter (Dec.-Jan.) of hatching (White, 1940) and represented the outside edge of the central kernel. Thus the succeeding opaque zone was the first summer's growth and the next (second) hyaline zone the second winter's growth. The age of the fish was therefore calculated by subtracting one from the number of winter hyaline bands.

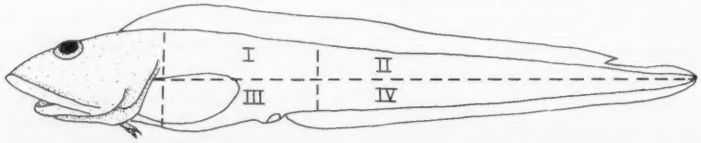

Figure 2.—Diagram of an ocean pout (*Macrozoarces americanus*) showing definition of fillet quadrats (after Olsen and Merriman, 1946).

Statistical Analysis

In order to determine if there were significant differences in the number of infections per individual between sexes or locations, a technique equivalent to two-factor analysis of covariance was applied to the data. The covariant selected was length, since it was the variable most highly correlated with the number of infections (see results).

Statistical models and computerized computational programs to perform factorial analysis of covariance for unequal numbers of replicates and a total sample size larger than 500, were not readily available. According to Gujarati (1970), equivalent results are obtained by the "dummy variable" technique. Application of this technique involved fitting the coefficients of the following linear statistical models according to the least squares criteria:

$$N_i = C_0 + C_1 L_i + C_2 D_{1i} + C_3 D_{2i} + C_4 (D_{1i} L_i) + C_5 (D_{2i} L_i) + e_i.$$

Where: N_i is the number of infections of the i^{th} fish,

L_i is the length of the i^{th} fish,

D_{1i} = 1 if the i^{th} fish is a female,
= 0 otherwise,

D_{2i} = 1 if the i^{th} fish is from location B,
= 0 otherwise,

e_i is a random variable with a normal distribution and mean of zero, and $C_0, C_1 \ldots, C_5$ are constants.

The constants of this equation were fit by multiple regression analysis using the IBM/360 computer of the University of Rhode Island and a program (MULTOT) available on that system. Gujarati (1970)

has shown that C_2 and C_3 are differential intercepts while C_4 and C_5 are differential slopes. Therefore, if C_2 and /or C_3 are not statistically significant, then there is no significant difference in the mean number of infections per fish when adjusted for length (difference in intercepts) between sexes and/or locations. If C_4 and/or C_5 are not significant, then there is no significant difference in the correlation of length with number of infections (difference in slopes) between sexes and/or locations.

RESULTS

The length frequency distributions for the three samples are shown in Figure 3. The length frequencies for males and females are plotted in Figure 4. The considerable overlap combined with the apparent sexual variation indicated that reliable age determination could not be based solely on length frequency data. These data are supported by previous observations by Olsen and Merriman (1946).

Otoliths were obtained from 557 of the samples collected, and from these the ages of 531 fish were determined. The average length of each age group is presented in Table 1 along with those estimated by Olsen and Merriman (1946). The mean length, weight, and age of the 531 fish for which the age was determined, were 525.3 mm, 764.7 g, and 5.6 years, respectively.

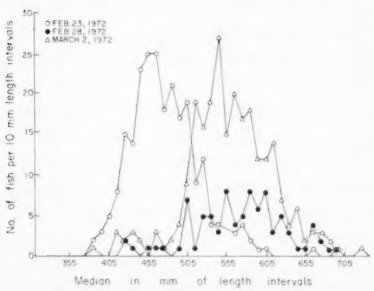

Figure 3.—Length frequency diagrams for samples of ocean pout (*Macrozoarces americanus*).

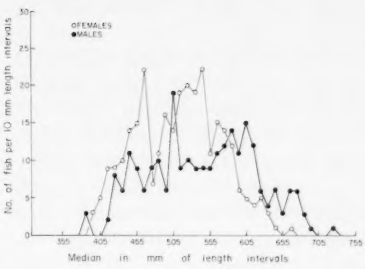

Figure 4.—Length frequency diagram of total sample of ocean pout (*Macrozoarces americanus*) by sex.

Further analysis of the data was divided into two stages. First, the relationships between the age, length, weight, condition, sex, and habitat with the average number of microsporidian infections per fish were examined. Second, the frequency of infections within specific quadrats of the fillets were considered.

The number of fish, mean number of infections per fish, and mean length of fish cross categorized by sex and location are shown in Table 2. The number of fish and mean number of infections per fish by year class are shown in Table 3. A total of 112 fish was infected, 29 with more than a single infection. The lesions ranged in length from about 0.1 to 4.5 cm. The color of the lesions ranged from chalky white to rust brown while their texture ranged from firm to soft semi-fluid structures best described as pockets of "pus."

The correlation coefficients of the age, length, weight, and condition of samples with the number of infections per sample were 0.109, 0.113, 0.097, and 0.078 respectively. Correlation coefficients larger than 0.088 are significant at the 5 percent level (based on 529 degrees of freedom; Snedecor and Cochran, 1967). Utilizing the computerized model described in the Methods and Materials section the following hypotheses were considered:

H_0: $C_2 = C_3 = C_4 = C_5 = 0$, and
H_1: $C_i = 0$ for at least one i, $i = 2, 3, 4, 5$.

According to Table 4 the null hypothesis (H_0) should be accepted, implying no statistically significant differences between sexes or location when adjustment is made for length.

The frequency of infection within specific fillet quadrats was examined by chi square analysis. The number

Table 1.—Mean length (cm) of ocean pout by age, collected from Rhode Island Sound during February and March of 1972 and collected from Massachusetts and Connecticut waters during May and June of 1944. (Olsen and Merriman, 1946.)

Age (years)	Rhode Island Sound early spring, 1972 sample size 531	Massachusetts and Connecticut, late spring, 1944 sample size 350
0	17.7	7.5
1	32.0	13
2	40.9	22
3	45.5	31
4	48.2	40
5	53.5	48
6	56.9	56
7	59.4	63
8	61.5	70
9	64.9	76
10	55.7	81
11	64.3	85
12	67.8	89
13	66.5	92

Table 2.—Number of fish, mean number of infections per fish, and mean length in mm of fish cross-categorized by sex and collection location. Locations A and B are defined in text and in Figure 1.

Sex and location	Number of fish	Number of infections/fish	Length in mm
Male, A	160	0.350	570
Female, A	161	0.376	541
Male, B	81	0.248	473
Female, B	129	0.147	466
Total	531	0.290	525

Table 3.—Number of fish and mean number of infections per fish by year class.

Year class	Number of fish	Infections/fish
1	1	0.0
2	4	0.0
3	5	0.200
4	46	0.196
5	110	0.255
6	205	0.293
7	101	0.287
8	31	0.161
9	12	0.750
10	7	1.000
11	4	1.500
12	3	0.0
13	1	0.0
14	1	0.0
15	0	—

of lesions in each quadrat for males and females, right and left fillets, and totals are presented in Table 5.

Results indicated that there were significantly more lesions in the anterior ventral fillet quadrat (III). The remaining three quadrats (I, II, IV) each had less than one-third the total number of lesions found in quadrat III. There was no apparent difference in the distributional pattern of lesions between males and females or between the left and right fillets.

DISCUSSION

Table 1 reveals some difference between the mean lengths of year-classes reported in this study and the work of Olsen and Merriman (1946). The current study was not intended for the calculation of growth curves, although such an effort may be reported at a later time. These differences may result from inadequate sample sizes within specific year classes as well as natural spatial and temporal variation in the growth rate.

In general the infection rates determined by Olsen and Merriman were higher than the rates reported in this paper. Specifically, the former study found that 64 percent of the 285 fish examined from the Block Island area during March were infected, while the latter found 29 percent during the same season. Of the Block Island fish that were infected, 69.5 percent had more than one lesion in the Olsen and Merriman study while only 25.9 percent of the fish infected had multiple lesions in the present study. Sandholzer et al. (1945) conducted field studies during March, April, and May 1943 in the waters from Cape May, N.J. to the northern tip of Cape Cod, Mass. The percentage of parasitized fish ranged from 4 to 38 percent depending upon the location. It is interesting to note that while Sandholzer et al. (1945) found the areas adjacent to Block Island and Muskeget Channel to be those with the lowest frequency of infection, Olsen and Merriman (1946) encountered a comparatively high incidence of parasitism in the area adjacent to Block Island and Muskeget Channel. Sandholzer et al. did not report the size of their samples. Therefore the results must be questioned. Many explanations could account for these differences including spatial and temporal variation in the rate of infection and variation in candling techniques.

The results and analysis reported in this paper confirm statistically Olsen and Merriman's (1946) view that the level of parasitism is uniform between sexes. No significant differences were found in the level of infection per fish between the two locations sampled. More areas should be sampled before drawing general conclusions concerning spatial variations in the levels of infection.

The correlation between the number of infections and the length, weight, or age of fish was low although statistically significant. Such low correlations make it doubtful that the infection rate of the catch could be greatly reduced by a management scheme designed to harvest the stock at a young or smaller stage. However, more intensive sampling of large and small fish is needed.

Similar results to those reported in this paper concerning the locations of lesions within fillets, were described by Olsen and Merriman (1946). They found a greater incidence of lesions in the abdominal region than posterior to the anus. Sandholzer et al. (1945) suggested that the portal of entry for the parasite may be through the gut since there is no evidence of external parasitism. The relatively heavy infection rate of the anterior ventral quadrat also lends support to his hypothesis. The fact that the lesions are not restricted to the gut area implies that the blood stream may enter into the distribution of the parasites as well (Olsen and Merriman, 1946).

Cats and pigs were fed infected ocean pout by Sandholzer et al. (1945) for short periods of time, and showed no ill effects up to a month following the experiments. In addition, no case of ill effects in humans resulting from consumption of infected ocean pout was ever documented. Although more ambitious experiments to determine the safety of human consumption of infected ocean pout are warranted, the problem of providing an aesthetically acceptable product seems more pertinent at present.

Since most of the infections are localized within the fillet, quadrat III, it seems reasonable to wholly remove this portion and selectively remove lesions from the remainder, assuming that storage techniques can be developed that eliminate the reappearance of lesions following candling. The history of the redfish fishery may serve as an example for the potential development of the ocean pout fishery as was suggested by Olsen and Merriman in 1946. Despite early problems with parasitic infection, which required routinely cutting the parasites from the fillets as they passed over a candling panel, the development of the frozen food industry in the 1930's served to stimulate a transition of the redfish from a trash fishery to

Table 4.—Analysis of variance testing for differences in the mean number of lesions per fish between locations and sexes when adjusted for length.

Source	*d.f.*	*SS*	*MS*	*F*
Regr(L)	1	3.544	3.544	6.848**
Regr(D_1, D_2, D_1L, D_2L)	4	1.905	0.476	0.9211
Error	525	271.788	0.518	
Total	530	277.237		

** Significant at 1% level

Table 5.—Number of lesions per fillet quadrat cross categorized by sex and right or left side.

Sex and side	Quadrat			
	I	II	III	IV
Male, right	7	4	24	4
Male, left	8	12	22	4
Female, right	9	4	18	6
Female, left	3	2	31	7
Total	27	22	95	21

a food fishery. The total catch of redfish in the western Atlantic (west of Cape Farewell) has ranged from an almost insignificant level prior to 1930 to as high as 390,000 MT in 1959. The 1969 catch was about 210,000 MT (Kelly et al., 1972). The success of the redfish industry should encourage those interested in reestablishing the prominence of the ocean pout fishery.

This study represents an initial step toward determining the future value of the ocean pout as a source of protein for human consumption. The development of a food fishery for ocean pout will require the design of a management scheme that can provide a safe protein product that is aesthetically acceptable to a large group of consumers at a marketable price. Selective removal of the most probable region of infection is one step in this direction.

ACKNOWLEDGMENTS

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MFR PAPER 1065

The food service industry evaluates a fish cake made from underutilized species.

A Report on the National Marine Fisheries Service Comminuted Fish Cake Survey

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INTRODUCTION

For the past two years, the National Marine Fisheries Service (NMFS) has been engaged in utilization research involving comminuted or minced fish flesh. The objectives of this research have been to develop marketable product forms which will:

(1) Facilitate the greater usage of underutilized species, and

(2) Enable companies to recover and sell a higher percentage of the flesh from all harvested fish.

One of the results of this research has been the development of a comminuted fish cake produced from species such as whiting, ocean perch, and hake. In recovering the fish flesh used in preparing the comminuted cakes, a meat-bone separation process is used as opposed to the traditional filleting technique.[1] A description of the specific recipe and the processing method for the fish cake appears in Appendix II.

This survey was aimed at the food service industry, which is a large user of portion controlled items. Producers of fishery products traditionally have found the institutional markets highly receptive to their product lines. Small to medium size processors, who are in the majority among fishery product firms, can particularly take advantage of these institutional markets.

The stiff competition for shelf space in retail stores makes it difficult for the smaller processors without a brand image supported by national advertising to gain entry into the retail market. Moreover, there are presently several national brand fish cakes on the retail market, and the NMFS test product may not be sufficiently differentiated in terms of quality or price to interest retailers in adding it to their product line.

For these reasons, it was decided market evaluation efforts would center on food service operations such as in-plant feeders, hospitals, universities, and school lunch programs. The survey was conducted by NMFS marketing specialists in 10 cities. Contacts were made with a total of 90 establishments, of which 73 tested and evaluated the product.[2]

SURVEY RESULTS

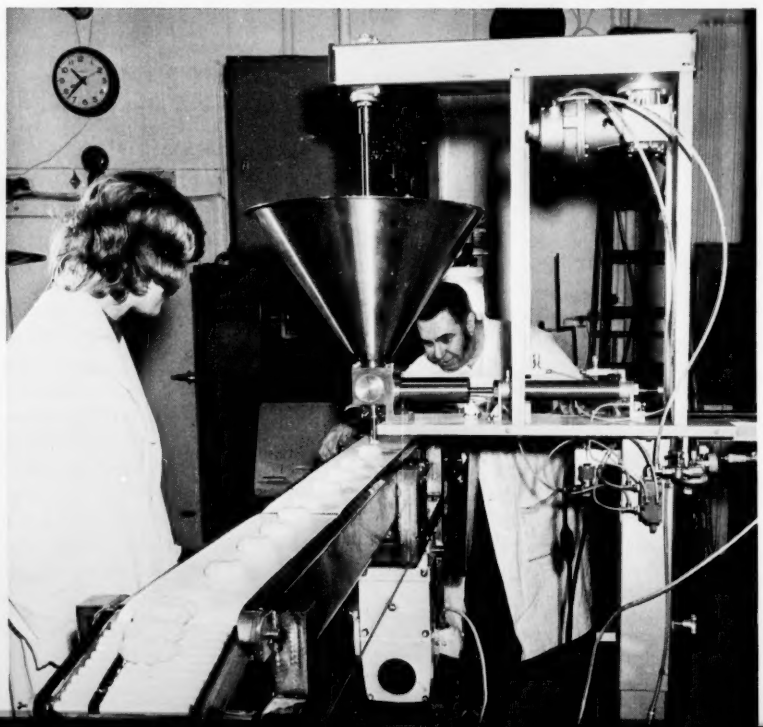
The following is an analysis of the survey responses which highlight the important factors bearing on product acceptability:

(1) Forty-three percent of all respondents indicated a willingness to buy the product. The highest favorable response (50 percent) was re-

[1] A full description of the meat-bone separation process can be found in the following: King, Frederick J. 1973. Improving the Supply of Minced Blocks for the Fish Stick Trade: A Progress Report. *Marine Fisheries Review* 35(8):26-32. MFR Paper 998.

[2] A full discussion of research rationale and methodology can be found in Appendix I.

Extruding equipment forming fish cakes.



corded by food service outlets not currently using fish cakes.

(2) Establishments without prior experience in using fish cakes in their operations reacted more favorably to the flavor of the test product than those who had previously used (or were using) a similar product. Among respondents who were not using fish cakes, but apparently had sampled them in the past, 60 percent of food service respondents and 50 percent of school lunch respondents rated them slightly better to much better in terms of flavor than other fish cake products they had sampled. In comparison, the percentages for food service and school lunch operations using fish cakes were 28 percent and 14 percent respectively.

(3) In all categories of respondents, the ratings for texture were lower than those for flavor. A majority of the negative comments received made reference to a "mushy potato-like" texture of the product and a low amount of fish flesh.

(4) As would be expected, food service companies were willing to pay more for the product than the school lunch trade. Also, in both categories, respondents who had not used a similar product were willing to pay more than those who had. The heavy majority of school lunch respondents would want to pay under 60 cents per pound, whereas a substantial proportion of the food service respondents would pay over 60 cents.

(5) The 3-ounce cake size was the choice of most school lunch respondents, while the food service trade expressed interest in 2, 3, and 4-ounce cakes.

(6) The 10-pound carton was the most popular size of package. However, the food service firms which were using fish cakes expressed considerable interest in the 5-pound container.

(7) School lunch personnel were primarily interested in recipes as marketing aids, while food service respondents saw a need for table tents and menu clipons, as well as recipes. One food service company requested that the product be supported by national advertising efforts.

(8) The open-ended comments received were classified into positive and negative categories and a third category containing suggestions. Over half of the comments were of a negative nature, mostly relating to the product texture. The most common remark was that the product was too "mushy," and did not have enough of a fish texture. The consensus was that the product could be improved by adding more fish to the formulation. Several respondents also thought that the breading was too tough. It should be noted that some school lunch personnel questioned whether the product contained the proper protein levels for use in their feeding programs. Protein specifications would have to be met if any firm was considering the school lunch market. Some respondents suggested that the cakes should be larger and flatter, while others objected to garlic and far too much salt.

Tables 1 and 2 show the tabulation of responses by each question.

CONCLUSIONS

Overall, the product was found to be acceptable to a significant proportion of the respondents. However, as has been indicated, the comment concerning the fish cake that continuously appeared was one related to texture. There was a consensus that more of a fishlike texture (and in some cases taste) was required. An interesting corollary to this point was that some of those, although giving the test product low marks on texture, would still be willing to purchase it for use in their operation. One could conclude that product quality in terms of taste and texture is not as important as possibly price considerations in selling to the food service market, although even some of those who indicated they would buy the product stated the need for product improvement. From all of the comments received, it was apparent that reformulation of the product will be required to assure continuing wide acceptance.

The range of acceptable prices was quite broad in both food service and school lunch categories. However, about 40 percent of the prices given did fall between 40 cents and 70 cents per pound. Based on our data, the upper limits of this range would be more acceptable to the food service trade, while prices closer to 40 cents per pound would probably be within the cost requirements of most school lunch operations.

APPENDIX I

Research Rationale and Methodology

It was the intent of this survey to obtain an evaluation of the NMFS fish cake from representative firms in the food service industry. Included in the evaluation were to be opinions on product qualities, expected prices, promotion, and other factors concerned with the potential marketability of the product.

Rationale

The judgment of NMFS technology and marketing personnel was that the food service market offered the best opportunity for the fish cakes.

This determination was based on the following factors:

(1) Stiff competition for shelf space in retail stores makes that market a poor alternative for the small-to medium-sized processor without a brand image supported by national advertising.

(2) There are presently several national brand fish cakes on the retail market. The NMFS test product is not sufficiently differentiated in terms of quality or price to interest retailers in adding it to their product line.

(3) The promotional effort required to successfully introduce a new product would probably be beyond

the financial resources of a small-to-medium-sized firm.

(4) The large volume requirements of retail food chains could be beyond the capabilities of a small-or-medium-sized processor.

(5) The food service or institutional market for the most part, contains none of the above disadvantages for the processor. A firm which can provide the required quantity and quality at the right price can enter the food service market without substantial promotional outlays. Marketing efforts are primarily directed towards food service purchasing agents. Any extensive promotional effort, if done at all, is carried out by the food service firms. The absence of a national image or resources to conduct extensive advertising efforts would not be a barrier in this market. The diversity in size of food service firms compared with the uniformly large retail food operations presents many more opportunities for the small-to medium-sized firm.

Methodology

For the reasons stated, it was decided market evaluation efforts would center on food service operations such as in-plant feeders, hospitals, universities, and school lunch programs. NMFS marketing specialists in Gloucester, Mass.; New York, N.Y.; Baltimore, Md.; Atlanta, Ga.; St. Petersburg, Fla.; Dallas, Tex.; St. Paul, Minn.; Los Angeles, Calif.; San Francisco, Calif.; and Seattle, Wash. were requested to identify potential food service operations that would cooperate in evaluating the fish cakes. These contacts were chosen on a judgment basis, as we were not planning to attribute the results to the full universe of institutional feeding operations.

Ninety food service operations in the 10 market areas mentioned above were contacted in person by NMFS marketing personnel and provided with samples, questionnaire, and background information on the test product. Where feasible, the fish cakes were evaluated and the questionnaire completed in the presence of the marketing specialist. If this was not possible, the evaluator was requested to mail the completed questionnaire to the local marketing office at his earliest convenience. In certain cases, follow-up calls were made to obtain the questionnaires. From these 90 contacts, 73 usable questionnaires were obtained. The responses were categorized in the following manner:

	Number of responses	Range of meals served daily by respondents
School lunch programs	25	1,000- 40,000
Food service management firms	13	1,500-400,000
In-plant feeding operations	17	95- 64,000
Hospitals	7	1,000- 4,000
Universities	4	4,500- 18,000
Other	7	400-600,000
Total	73	

Table 1.—Tabulation of responses by question.

	School lunch				Food service			
	[1]Yes	(7)	[2]No	(18)	[1]Yes	(21)	[2]No	(27)
	%	#	%	#	%	#	%	#
I. Would buy this product								
Yes	44%	3	33%	6	48%	10	50%	13
No	28	2	28	5	48	10	43	11
No comment	28	2	39	7	4	1	7	2
Total	100%	7	100%	18	100%	21	100%	26
II. Rating of flavor								
Much better	14%	1	7%	1	14%	3	36%	9
Slightly better	0	0	43	6	14	3	24	6
About the same	14	1	36	5	29	6	8	2
Slightly poorer	72	5	14	2	29	6	20	5
Much poorer	0	0	0	0	14	3	12	3
Total	100%	7	100%	14	100%	21	100%	25
III. Rating of texture								
Much better	0%	0	0%	0	5%	1	17%	4
Slightly better	0	0	21	3	5	1	25	6
About the same	14	1	36	5	30	6	8	2
Slightly poorer	57	4	28	4	25	5	29	7
Much poorer	29	2	15	2	35	7	21	5
Total	100%	7	100%	14	100%	20	100%	24
IV. Price per pound willing to pay								
Under 60¢	100%	4	82%	9	58%	8	42%	6
60¢ and over	0	0	18	2	42	6	58	8
Total	100%	4	100%	11	100%	14	100%	14
V. Desired cake size								
2 oz.	14%	1	7%	1	37%	7	26%	6
2½					5	1	4	1
2½-3			7	1	5	1		
3	86	6	65	9	11	2	30	7
3-4			7	1			14	3
4			14	2	32	6	22	5
4-5					5	1		
4-6							4	1
5					5	1		
Total	100%	7	100%	14	100%	19	100%	23
VI. Size of pack desired								
5 lbs.	14%	1	6%	1	48%	9	24%	5
10 lbs.	57	4	50	8	21	4	52	11
15 lbs.	0	0	13	2	5	1	5	1
20 lbs.	29	2	31	5	26	5	19	4
Total	100%	7	100%	16	100%	19	100%	21
VII. Selling tools needed								
Table tents	0%	0	0%	0	21%	3	33%	6
Menu clipons	0	0	40	4	36	5	39	7
Recipes	100	4	60	6	43	6	28	5
Total	100%	4	100%	10	100%	14	100%	18

Numbers in parentheses at top indicate total number of establishments surveyed in each category.
Numbers in the # columns indicate the number of responses.
[1] Yes—currently using a fish cake product.
[2] No—not currently using a fish cake product.

As demonstrated above, there was considerable variation in the size of the organizations in the sample, particularly in the food service area. For example, the food service management and in-plant feeder categories contain national food management organizations, large corporations running their own employee feeding program, and small independent operations. However, there were not enough organizations of different sizes in each category to justify separate treatment.

Instead, the responses were divided into two main groups: food service

and school lunch. School lunch respondents were differentiated based on requirements food products must meet to be used in school feeding programs. All the food service operations, regardless of location, e.g., in-plant cafeteria, university, etc., were grouped together because of similar requirements: relatively low priced and convenient food items. However, they differ from school lunch programs in that commercial food service operations have no specific protein requirements that must be met and are generally able to afford higher food costs.

Both groups were subdivided into those who have used a fish cake and those who have not. We believed that the evaluations would vary enough, based on the amount of experience with a fish cake product, to analyze separately.

Table 2.—General comments.

	School lunch		Food service	
	Yes	No	Yes	No
Negative				
(1) Needs a firmer fish texture and flavor, less potato	4	8	10	11
(2) Does not contain required 2 oz of protein		4		
(3) Breading is tough		2	1	4
(4) Overbearing fish smell			1	
Total	4	14	12	15
Positive				
(1) Good taste				1
(2) Product is good as is				4
(3) Good breading				1
Total				6
Suggestions				
(1) Make flatter	2	3		1
(2) Make larger	2		1	
(3) National advertisement needed				1
(4) Omit garlic	1			
(5) Use less salt				1
(6) Make in shape of finger food for smaller children	1			
(7) Make less dry				1
(8) Add yellow color and pimiento				1
(9) Make shape similar to a fillet				1
(10) Use as a ½ oz hors d'oeuvre				1
(11) Use textured vegetable protein in place of potato				1
(12) Could be used on a bun				1
(13) Deep fat frying—best cooking method				1
Total	6	3	1	10

APPENDIX II

Processing Technology and Description of Product

In developing the comminuted fish cake, the National Marine Fisheries Service's Atlantic Fishery Products Technology Center has taken advantage of underutilized species caught locally, such as whiting and red or white hake that have limited marketability in traditional product form.[3]

A meat-bone separator is used to collect the maximum amount of fish flesh. The flesh is then mixed with the ingredients as shown in the recipe and blended. This mix is fed into a former which can make cakes, puffs, or portions. The product is then put through a batter and breading machine, deep-fat-fried, and frozen in a carbon dioxide freezer tunnel. The product is then packaged, overwrapped, and stored frozen until ready for use. To be eaten, this convenience-type product is heated in an oven at 400°F for 20 minutes or until hot.

Fish Cake Recipe

Ingredients	Weight	Percent
Whiting or hake (minced flesh)	33.0 pounds	43.27
Water (hot)	18.0 pounds	23.06
Potato flakes	6.0 pounds	7.68
Salt fish (rapid salt-cured)	3.0 pounds	3.84
Bread crumbs (unflavored)	2.0 pounds	2.56
Onion (minced)	140.0 grams	.39
Parsley flakes	20.0 grams	.05
Ribotide	13.0 grams	.03
Garlic powder	10.0 grams	.02
Pepper (white)	10.0 grams	.02
Citric acid	3.0 grams	<.01
Allspice (ground)	2.0 grams	<.01
Batter and breading	15.62 pounds (7,091.5 grams)	20.01

[3] A further discussion of this work can be found in the following: Anderson, M.L., and J.M. Mendelsohn. 1971. A Study to Develop New Products from Whiting or Other Underutilized Species. Technical Assistance Project No. 01-6-09131. U.S. Department of Commerce. Economic Development Administration.

MFR Paper 1065. From Marine Fisheries Review, *Vol. 36, No. 5, May 1974. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*

U.S., Brazil Agree on Shrimp Conservation

The Commerce Department's National Oceanic and Atmospheric Administration is now administering a law implementing an agreement with Brazil dealing with the conservation of certain shrimp resources located off Brazil. The Act, signed into law by President Nixon earlier this year, has an amendment designating the American lobster (*Homarus americanus*) as a creature of the Continental Shelf, thus affording the lobster additional protection from foreign fishing.

The legislation, known as the Offshore Shrimp Fisheries Act of 1973, formalizes an agreement with Brazil under which the Brazilian Government has, with the United States, undertaken to enforce conservation regulations, thus protecting a marine resource of great value to U.S. shrimp fishermen who operate in what the United States terms international waters along the Brazilian coast north of the Amazon River.

From 1959, when it began, through 1972, the fishery which extends from the Guianas to the mouth of the Amazon yielded about 350 million pounds of shrimp (heads off). In the first nine months of 1973 the Guianas fisheries area yielded about 9.8 million pounds of shrimp (heads off) worth close to $16 million on the U.S. market.

NOAA's National Marine Fisheries Service will administer the law as it applies to U.S. fishermen. However, under the treaty, the government of Brazil will enforce the law on behalf of the United States in the area covered by the agreement, in conjunction with the Departments of Commerce and Treasury, and the U.S. Coast Guard.

The lobster amendment to the Offshore Shrimp Fisheries Act was added by the Senate Commerce Committee, headed by Senator Warren G. Magnuson. The amendment will have the effect of reserving American lobsters found on the Continental Shelf for U.S. fishermen.

The new U.S. law now in effect prohibits taking American lobsters by vessels of other countries, and all lobsters caught by these vessels must be returned to the sea immediately regardless of condition.

The American lobster is one of several species that have been identified for cooperative management under the NMFS State-Federal Fisheries Management Program. A regional council comprising fisheries agency directors of the 11 coastal States from Maine to North Carolina and the NMFS Northeast Regional Director is currently developing a resource-wide management plan for this valuable species. Designating the American lobster a "creature of the Shelf" is considered a major step in furthering the progress of the management plan.

At a meeting in Baltimore, Md., about a year ago the council stated: "The American lobster would be managed to insure its preservation as a viable resource once ownership of this resource rests in the United States." The amendment to the Offshore Shrimp Fisheries Act of 1973 now provides for such exclusive sovereign rights and, therefore, appears to remove a major roadblock to implementation of the management principles agreed to at the Baltimore meeting.

Northeast Pacific Charts Scheduled

The National Oceanic and Atmospheric Administration has announced that it will undertake the preparation and production of nautical charts for the northeast Pacific Ocean, covering a vast area extending from the West Coast to Hawaii to Alaska. The first two charts are planned for issuance in 1975, with two more to follow in 1976, and the final chart in 1977.

The work will be done by NOAA's National Ocean Survey, the government's chart-producing agency for U.S. coastal waters. The charts will be prepared by the agency's Office of Marine Surveys and Maps, headed by Captain Robert C. Munson. One chart, covering the area from the West Coast to Hawaii, will be published at a scale of 1:10,000,000, the remainder at a scale of 1:3,500,000.

These will be the first international charts to be produced by NOAA, a Department of Commerce agency, as part of a multination program being sponsored by the Monaco-based International Hydrographic Bureau. Other nations which have agreed to produce and issue international charts are Canada, West Germany, United Kingdom, France, Brazil, Argentina, Chile, Italy, Netherlands, Japan, India, New Zealand, Australia, and possibly South Africa.

The program is designed to provide a standard series of charts for the entire world which can be used by all nations. Each member nation is authorized to reprint charts in its own language, but employing the same form of navigational information, such as depth curves, sounding spacing, aids to navigation, and nautical symbols. All data will be in metric units. Some international charts already have been issued, including a chart for the western section of the North Atlantic Ocean by the U.S. Defense Mapping Agency.

NMFS Seeks Fish Name Standardization

Common names of various species of fish have long presented problems of identification and labeling of fishery products because the same species may be known by different names in different parts of the country, or even in the next county.

On parts of the east coast "rockfish" refers to what elsewhere is known as striped bass, but on the west coast "rockfish" is the common name for more than 20 other species. Along the Atlantic coast, the fish known as alewife or bunker in Chesapeake Bay is called by its more common name, menhaden, elsewhere and as far south as the Gulf of Mexico. The problem is receiving special attention from the Commerce Department's National Oceanic and Atmospheric Administration.

NOAA's National Marine Fisheries Service points out that several thousands of marine food species have taxonomically accurate scientific names that are recognized throughout the world by fisheries scientists, but because of different common names in different locales, the situation leads to confusion in the marketplace, is not in the public interest, and defies regulatory controls. The problems are accentuated in that many nutritious products are available from species known by names that are commercially objectionable.

NMFS Director Robert W. Schoning said that confusion exists concerning naming and labeling new product forms manufactured from multiple ingredients and various species of fish. Mr. Schoning said that the regulation of matters dealing with common or unusual names of foods is the primary responsibility of the Food and Drug Administration. Decisions on permissible names for fishery products generally have been reached through formal and informal agreements on a case-by-case basis. One of the basic problems, Mr. Schoning said, is that the uncertainty with respect to product names inhibits technology and commerce in fishery products especially with species that are abundant, but not fully utilized in U.S. markets.

Mr. Schoning said that under existing statutes NMFS is responsible for grade standards and descriptions of fishery products, and among other things, conducts an extensive consumer education program. He said that a logical and necessary extension of these activities would cover matters pertaining to market nomenclature for fishery products and to providing an improved procedure for establishing or changing legally acceptable names.

As a first step, Director Schoning said he would appoint an expert in the field to coordinate development of an improved procedure to achieve the nomenclature objectives. The coordinator will contact and work with all interested parties in the private and public sectors, and maintain close liaison with the FDA.

U.S. and Russian Marine Mammal Scientists To Expand Scientific Cooperation, Research

Soviet and U.S. scientists have agreed on an enlarged program of scientific cooperation and research on marine mammals, following a meeting in Washington, D.C. late last year. Scientists of the two countries will expand cooperative studies and meet more frequently in pursuit of improved conservation and management of marine mammals.

Marine mammal experts from Soviet agencies exchanged data and opinion with their American counterparts in the U.S. Departments of Commerce and Interior on matters concerning whales, seals, sea lions, sea otters, walrus, and polar bears. Also in attendance were scientists of the U.S. Public Health Service in Alaska, the Alaska Department of Fish and Game, and several private scientific organizations.

The meeting of the Marine Mammal Subgroup—second in a series sponsored by the Commerce Department's National Oceanic and Atmospheric Administration—generated impressive results in terms of concrete plans for a series of far-reaching bilateral investigations of the life cycles and environmental conditions of several species of marine mammals.

Discussion centered on such topics as:

1. The standardization of methods and forms used by the two countries to record biological observations and sightings of pinnipeds (seals and sea lions) and cetaceans (whales and porpoises) at sea.

2. The need for attention to technological improvements in presently available methods used to mark or tag marine mammals.

3. The continuation of national research programs conducted in each country which seek to define both the population dynamics and the biological cycles of gray and bowhead whales.

4. An increased effort by both countries to acquire biological data concerning the Beluga (in Russian "Belukha") whale.

5. Additional consideration of the experimental use—so far limited to the United States—of remote sensors to monitor walrus populations on North Pacific ice packs and the possible application of similar techniques to whales at sea, on a cooperative basis.

6. Increased collaboration between Soviet and American scientists in existing and proposed studies of the physiology, morphology, distribution, and ecology of several kinds of seals and walrus, to include visits to Russia by U.S. scientists.

7. The possible contributions Soviet

scientists might make to a proposed U.S. study of the incidence and metabolism of heavy metals in marine mammals.

8. The agenda for a 1974 symposium on the biology and conservation of North Pacific walrus in Russia in which U.S. members of the Marine Mammal Subgroup will participate.

The United States also suggested that Russian scientists take part in studies of gray whales carried on under the direction of the NMFS Northwest Fisheries Center (Seattle, Wash.), tentatively planned for 1975 on the Baja California breeding and calving grounds. A Soviet scientist was invited to participate in U.S. research on the northern fur seal-northern sea lion relationship, to take place on the Pribilof Islands in 1974. (The U.S. early in 1973 declared a moratorium on seal harvests on St. George Island, in part so a protected seal population could be compared with a harvested one on nearby St. Paul Island.)

Representatives of both countries confirmed the value of regularly scheduled exchanges of scientific data and opinion on ocean mammals, and said they hoped for an expansion of the close association that has developed since the United States activated the Marine Mammal Protection Act of 1972. Within Commerce, NOAA's National Marine Fisheries Service is in charge of the implementation of the Act, in consultation with the U.S. Marine Mammal Commission.

The USSR many years ago established a conservation program that restricts the taking of marine mammals by Soviet citizens to a few exceptions granted by special permit, e.g., subsistence take by Siberian Eskimos. That program comes under the supervision of the USSR's All-Union Research Institute of Marine Fisheries and Oceanography (known familiarly by its Russian initials, "VNIRO"). VNIRO's responsibilities for marine mammals within Soviet boundaries are similar to those of NOAA's NMFS.

RUFAS II, Robot Diver, Expected To Locate Commercially Important Fishery Resources

A second generation robot diver that can inspect the seafloor at great depths is expected to aid significantly in locating commercially important stocks of fish and other undersea resources.

Named RUFAS II (for Remote Underwater Fisheries Assessment System), the instrument is towed behind a research ship, and dives on command to look at selected underwater features. Development of RUFAS II was under the sponsorship of two units of the Commerce Department's National Oceanic and Atmospheric Administration—the National Marine Fisheries Service, and the Office of Sea Grant through a grant to Mississippi State University.

RUFAS II is equipped with roving "eyes" that photograph the surrounding scene by videotape and 35 mm film, and continuously televise its observations to the mother ship. The 35 mm photo system can be activated to record interesting phenomena, then turned off to ignore barren stretches of sandy bottom.

Equipped with sonar beams, RUFAS II sends warning signals to the shipboard operators when underwater navigational hazards are detected, so the instrument's "flight pattern" can be altered electronically to avoid the obstacle, be it a rock or a change in the configuration of the sea floor.

RUFAS II came into being as a result of collaborative work by Dr. Sidney Upham, Mississippi-Alabama Sea Grant Director, and Dr. Edward F. Klima, former base director of the NMFS Pascagoula laboratory. Principal investigators on the project were Richard D. Benton, Associate Professor of Engineering Technology at Mississippi State University, and Wilber R. Seidel, Manager of the NMFS Harvesting and Technology Program based at Pascagoula.

The sophisticated electronic robot ("Looks like a monster waterbug," said one observer) underwent initial sea trials from the NOAA research vessel *Oregon II* in the Gulf of Mexico near Destin, Fla. The 12 by 7-foot, 1,000 pound sled skimmed and hovered over several miles of ocean bottom, looking up, down, and sideways to give scientists aboard the mother ship a fish-eye view of marine features from a few feet above the bottom to just beneath the surface. Tests demonstrated that RUFAS II can climb at a rate of 2.5 feet per second. It was towed at speeds up to six knots by a cable more than a mile long, to permit dives as deep as 2,400 feet.

One important feature that distinguishes RUFAS II from its predecessor, RUFAS, is an automatic flight control system, installed to obviate the need for continuous manual control of the vehicle, sometimes for as much as ten hours without interruption. The prototype for the new underwater surveyor performed excellently over the past several years in fisheries resource explorations in shallow water (up to 50 fathoms). NMFS used RUFAS repeatedly to seek out and define populations of scallops in southeastern coastal regions, covering more than 6,000 survey miles.

The first RUFAS was developed for shallow-water surveys in a cooperative effort by the General Electric Corporation of Bay St. Louis, Miss., and the NMFS Pascagoula laboratory.

Biological Tracer From Pacific Jellyfish May Assist Detection of Human Diseases

The mysterious glow of Pacific jellyfish may lead toward improved detection of certain diseases in humans.

With Sea Grant support from the Commerce Department's National Oceanic and Atmospheric Administration, University of Washington scientists have found that a substance called aequorin, which gives the jellyfish its glow, can also be used to measure minuscule changes in calcium concentrations in a person's body fluids or cells. Such changes frequently are early signals of cellular destruction in the body, and point to the onset of diseases such as metastatic carcinoma, bone dysplasia, cardiac dysrhythmias, parathyroid disorder, and others.

The scientists, Dr. Kenneth Izutsu, a physiologist, and Samuel P. Felton, a biochemist, produce a purified aequorin from the common jellyfish found in great numbers in Puget Sound at certain seasons. This jellyfish, known scientifically as *Aequorea aequorea*, can be seen to glow in the dark if held in a person's hand.

The Sea Grant scientists, who are staff members of the university's Fisheries Research Institute and Center for Research in Oral Biology, are developing two methods for using aequorin to measure the amount of calcium in such biological fluids as blood, saliva, urine, and cerebral spinal fluid. Changes in the amount of glow, or luminescence, is a measure of changes in the amount of calcium in the fluid being measured. Aequorin was first discovered in 1962 by Dr. Frank Johnson and Dr. Osamu Shimomura of Princeton University.

Four chemical companies have indicated interest in marketing aequorin on a test basis, or as a regular item in their catalogue, once the production methods are perfected. When this occurs, it is expected that all available supplies will be used by clinical chemists and physiologists.

The Sea Grantees point out that aequorin has two advantages over present methods of calcium determination: it is far more sensitive; and it does not require upsetting the balance of the system being measured. Aequorin can be used to measure calcium concentrations as low as 10^{-9} molar—approximately 40 parts per trillion. Aequorin is the only substance that can measure calcium within a single cell.

The scientists can obtain from 600 jellyfish enough aequorin for about 500 calcium measurements—about 35 milligrams of 30 percent pure aequorin. They catch the jellyfish in hand nets to prevent them from being crushed, and remove about ¼-inch of the very outside perimeter of the "umbrella", the only part that contains the bioluminescing protein. When 500-600 rings have been accumulated, they use a series of mechanical and chemical techniques to extract and purify the aequorin.

Aequorin is a protein that contains a non-protein portion. The non-protein portion is thought to be the light-emitting part of the molecule, but this has not yet been proven. The luminescence caused by the reaction of calcium and aequorin is measured by a photoelectric cell. Scientists do not yet understand the nature of the reaction that causes this release of energy in the form of light.

Physiological uses for aequorin are expected to be far-reaching, since before its discovery there was no way to test the calcium theory of cell function. This is a theory currently under investigation by many biologists, which suggests that calcium apparently acts to trigger hormone reactions in cells. To date, aequorin has been injected into the large muscle cells of the barnacle and into the giant nerve cells of the squid—both of which are convenient experimental models for human muscle and nerve cells. In both cases the importance of the calcium ion in regulating cell function has been confirmed.

The University of Washington scientists are also considering possibilities for non-medical applications of aequorin, such as studying the role of free calcium in fish spoilage and studying the role of calcium in the hatching of fish eggs.

The Sea Grant investigators have carefully observed the population of the jellyfish after several seasons of catching them for their work. To date there has been no noticeable change in the numbers of the animals in Puget Sound and San Juan waters where they are caught. Great care is being taken to ensure the continued survival of the species, and plans are being made to study more closely the habits of the animals.

Izutsu and Felton became interested in aequorin after the Princeton University team of Johnson and Shimomura suggested that the substance could be used for microdetermination of calcium. At that time no method existed for studying the effects of anesthetics on calcium ions released at nerve receptors. The Princeton scientists discovered that the aequorin luminescence requires calcium and thus is unlike the reaction of fireflies and other bioluminescent organisms, which require oxygen or a high energy source such as ATP (adenosine triphosphate) in order to take place.

The aequorin project was accepted as a part of the University of Washington Sea Grant program in 1971, and continues to receive partial support from NOAA's National Sea Grant Program. The University of Washington was one of the first four universities in the nation to receive the Secretary of Commerce's designation as "Sea Grant College".

Japanese Government Willing To Impose Fishing Restrictions to Protect Halibut

The Japanese Government has indicated its willingness to impose voluntarily important restrictions on its fishing fleet in 1974, designed to protect dangerously depleted halibut stocks in the eastern Bering Sea. The actions are undertaken as part of a three-nation conservation program with the United States and Canada, under the aegis of the INPFC (International North Pacific Fisheries Commission).

Japanese draft measures incorporating the new conservation moves, which were based on recommendations initiated by the IPHC (International Pacific Halibut Commission), have been studied and approved in a series of recent meetings with U.S. and Canadian officials. Representatives of the Commerce Department's National Oceanic and Atmospheric Administration, whose National Marine Fisheries Service is deeply involved in the U.S. effort to conserve and protect marine resources, participated in the discussions. The consequent understandings as to voluntary measures to be taken by Japan will be made a matter of official record without delay through circulation by the INPFC to the three governments, together with the INPFC's recommendations for joint measures to conserve halibut in the eastern Bering Sea. The new understandings stated that Japan would take the following additional domestic measures in 1974 for the purpose of protecting the halibut fishery:

1. prohibition of operations of mothership and North Pacific trawl fisheries in Area A south of 55° 30′ North Latitude January 1 to March 31, 1974. The closure will apply for next winter also, but will begin on December 1, 1974.
2. prohibition of operations of mothership and North Pacific trawl fisheries in Area E south of 56° North Latitude December 1 to March 31. This closure will begin in December 1974.

The new Japanese measures were agreed upon in the weeks following the annual meeting of the INPFC held at Tokyo last November. Japan noted at the Tokyo conference that it would institute certain domestic conservation measures for halibut in the eastern Bering Sea including continuation of the ban on retaining trawl-caught halibut in most areas, increasing the minimum size limit from 26 to 32 inches, and other measures including improved enforcement. However, disagreements arose at that meeting concerning proposals made by the United States and Canada that Japan further curtail its trawl fishery in the eastern Bering Sea, believed to have a definitely destructive effect on halibut stocks because of the capture of large numbers of juvenile halibut in the fishery's "incidental" catch. The Tokyo meeting ended in an impasse on the halibut question. For the first time since 1963, the INPFC failed to recommend halibut conservation measures for the eastern Bering Sea at its annual conference.

Robert W. Schoning, Director of the NMFS and a U.S. Commissioner on the IPHC, and an Alternate U.S. Commissioner on the INPFC, said that the United States is pleased at the Japanese decision to take a greater part in international endeavors to protect a valuable marine asset through the expedient of setting a ban on trawling in certain areas and periods to reduce rates of capture and resultant high mortality of juvenile halibut.

Mr. Schoning said that the Japanese moves showed definite progress toward meaningful and concerted conservation action within INPFC through its member nations, Canada, Japan, and the United States.

Canadian Report Recommends Trade: Port Use for Fish

A suggestion that Canada should bargain with other countries for the wider use of east coast ports in return for a bigger share of the Atlantic fish catch, rather than closing its ports altogether is one of a number of recommendations contained in a report on east coast port use by Dr. E.P. Weeks, Chairman of the Canadian Saltfish Corporation.

The 180-page report focuses on the activities of foreign fleets fishing off Canada's east coast and details their calls and expenditures at Canada's ports. It also estimates the financial losses which would result from closing these ports to foreign fishing vessels buying oil, food and other supplies.

The report suggests that Canada's chief aim in bargaining for use of port facilities should be a reduction in the present intense foreign fishing off the Atlantic coast, thus benefiting Canada's own offshore and inshore fishermen.

Dr. Weeks states that a review of the broad picture of the Canadian ports and foreign fishing fleets "leads to the general conclusions that Canada should adopt, as the basis of negotiations with interested countries, port use in the full sense rather than closure." He adds: "This would work to the advantage of Canadian ports, of the Canadian primary fishery, of processors, of employment and the economy in general, as well as being of value to the foreign countries concerned."

The report contends that port closure by itself would not likely result in any appreciable decline in fishing activity off the east coast by foreign fleets, which would still aim to take their ICNAF catch quotas regardless of the additional costs or inconveniences. However Dr. Weeks points out that the current oil situation accentuates the problems of distant water fishing fleets and is bound to increase their interest in the use of Canadian ports, not only on the present basis but even more in the way of specific new privileges for which they will be prepared to bargain.

The report states: "If the ports were opened to the extent of giving privileges for crew exchange, transshipment and storage, and the landing of fish, there would undoubtedly be a much larger number of port calls. These, in turn, would mean greater sales of goods and services." On the other hand, port closure—excluding emergency calls—would cause a loss of about four-fifths of foreign fleet expenditures in Atlantic ports.

On the basis of 1972 expenditures, this would amount to about $18 million, of which more than $16 million would be in Newfoundland and the remainder in Nova Scotian ports. St. John's, Nfld., where foreign fishing vessels make up nearly 40 percent of total calls, would be the hardest hit. The report estimates that total employment would decrease by approximately 2,500 man-years if the ports were closed to foreign vessels.

Under adequate safeguards, the landing of foreign fish could be of advantage to Canadian plants whose capacity is underutilized and to employment on a year-round basis, the report adds. Repairs to foreign fishing vessels in Canadian ports should involve the maximum use of local repair facilities, instead of the common practice of regarding the ports as a place to berth the vessels while foreign crews do the work.

Norwegian Fish Meal Is Well Received

Norwegian fish meal produced for human consumption has been enthusiastically received in 13 African and Asian countries, according to World Wide Information Service, Inc. The meal has been marketed under the name of "Norse fish powder."

By the end of 1973, 3,000 tons of fish meal were shipped from Norway to Bangladesh. Small quantities were exported to other countries—either as regular sale or as part of the Norwegian foreign aid program. Production has been going on at three factories in northern Norway and two in the south. This has been satisfactory for the quantities needed so far.

Japan Encourages Frozen Food Industry

The Kansai Cold-Storage Association has set up a new body called the Food Distribution System Association to develop the frozen food industry in Japan. As a part of the program, new cold storage construction has been encouraged. The Chuo Reito Co. completed the construction of a new cold-storage warehouse in Chuo Ward, Tokyo, with a capacity of about 27,000 short tons.

Australia Reports Tuna Developments

In recent months, the Australian Government has put over US $1,495,000 into fisheries research and development projects. Its policy is to develop the Australian fishing industry —particularly exports—to a "greater degree" than in the past, says World Wide Information Service, Inc.

Potential for tuna catches off Western Australia (WA) is supposed to be "huge," according to Australian researchers. It has been reported that several years ago, Japanese fishermen caught 40,000 tons about 150 miles off the WA coast. Current Australian catches are small. Interestingly, researchers project that Western Australia's rock lobster industry will not expand its current catch and could decline in two years.

Meanwhile, Safcol, Australia's major fishing cooperative (sales, over US$33 million), will build a US$3 million tuna cannery on New South Wales' south coast. The cannery will concentrate on processing skipjack tuna, which is smaller than the bluefin tuna currently caught in local waters. Fish will be caught by purse seine netting and several vessels have recently been built for the project.

Exploitation of skipjack could nearly double Australia's tuna catch and Safcol will look at the export market, possibly through a United Kingdom-based dealer. The cannery will be at Unanderra, near the steel town of Wollongong. It will employ 250 workers. Two unnamed companies will join Safcol in the cannery project. Safcol is also reported to have recently rejected a takeover offer from an undisclosed United States source.

South Africa Eyes Lobster, Hake Catch

South Africa has once again limited its rock lobster catch for the current season, November 1, 1973 through June 30, 1974, to 3.5 million pounds tail weight, according to World Wide Information Service, Inc.

Over the years, the catches of rock lobster have declined drastically, with the result that the South African Government has steadily lowered the catch-quota for local lobster fishermen, from 7.4 million pounds to the current figure. The scientist in charge of the South African Division of Sea Fisheries rock lobster research,

says, however, that there are optimistic signs of a recovery in the lobster population.

The South African fishing industry, fearing overfishing of the hake supplies, is urging the International Commission for the Southeast Atlantic Fisheries to impose a limit on the amount of hake caught in the Southeast Atlantic Region. The South African industry wants the annual catch restricted to 800,000 tons, with each nation fishing these waters agreeing to a quota system. The vast area of ocean off the South African and Southwest African coasts is yielding a harvest of 1 million tons of hake a year. South African boats account for about 100,000 tons of this. The remainder is caught by fleets from Russia, Spain, Portugal, Bulgaria, Cuba and Poland.

Cod Quotas Set By Three Nations

Delegations from Great Britain, the Soviet Union and Norway agreed in May 1973 to propose a limitation on arctic cod catches during 1974, reports the NMFS Statistics and Market News Division. According to the agreement the total quota was fixed to 550,000 tons with the following allocations: Norway, 242,850 tons; USSR, 179,500 tons; and Great Britain, 77,650 tons. In addition, Norway was to be allowed a coastal quota of 40,000 tons. The agreement is reported to have been accepted by the British government and there was a reported verbal acceptance from Moscow.

Australian 1972-73 Fish Exports Told

During the 1972-73 financial year, Australia exported edible fisheries products worth US$109 million, according to World Wide Information Service, Inc. Rock lobsters, prawns, abalone and scallops were the main export earners, making up nearly 92 percent of the total value.

ROCK LOBSTERS

The value of rock lobster exports fell from US$51 million in 1971-72 to US$49 million in 1973-74. The quantity of frozen tails exported was 4,600 tons, down 1 percent from the previous year, while the value fell 9 percent to US$45 million.

During 1972-73, the United States took almost all Australian rock lobster tail exports while France bought 44 percent of the whole rock lobsters, and Japan received 35 percent. Western Australia was the main rock lobster exporting state, shipping 70 percent of the rock lobster tails and 59 percent of the whole rock lobsters.

PRAWNS

Prawn exports in 1972-73, amounted to 6,505 tons—18 percent less than 1971-72. They were worth US$36 million, or 9 percent less than the previous year. Queensland shipped 37 percent of the total quantity of prawns; Western Australia, 23 percent; and Northern Territory, 22 percent.

Japan bought 79 percent, compared with 67 percent the previous year. Britain took 11 percent, and the United States and South Africa each took 4 percent.

SCALLOPS

Scallops exports rose 78 percent in quantity and more than doubled in value to 1,704 tons, worth a record US$7.5 million. The United States took 53 percent and France took 32 percent.

Publications

Alaskan Marine Resource Publications

The first in a series of three books on "Alaska and the Law of the Sea" has been published by the Arctic Environmental Information and Data Center (AEIDC), University of Alaska. A major study of the historic development and future of Alaska marine interests supported by the Alaska Sea Grant Program has gathered the information for the series.

The 70-page soft-cover book entitled **"Alaska and the Law of the Sea—National Patterns and Trends of Fishery Development in the North Pacific,"** was written by Eugene H. Buck, research analyst in fisheries for AEIDC.

Statistics compiled in the new book underscore the magnitude of foreign harvest versus Alaska harvest, showing where and on what species foreign fleets have harvested recently in the North Pacific a combined total of more than four billion pounds a year. It compares the United States catch with foreign catches for each species of commercially harvested fish and provides a general summary to be used in national and international fisheries discussion.

For each species, charts depict annual catches, the relative importance of various fishing districts and the divisions of the catch between nations. A page of text aids interpretation of statistics, and a map illustrates district subdivisions, major fishing areas and the general pattern

of national expansion across the region.

Species covered are shrimp; tanner crab; king crab; herring; pink, coho, chinook, chum and sockeye salmon; pollock; Pacific cod; Pacific Ocean perch; blackcod, and halibut and other flatfish.

The new publication should be a useful handbook for fishermen, scientists and agencies responsible for fisheries management. The book provides a basis for asking important questions about management practices and their effect on fisheries, and may be used as a foundation for pursuing statistics on fisheries in more detail.

Copies of the book are available for $3.00 postpaid from AEIDC, University of Alaska, 142 E. Third Ave., Anchorage, AK 99501.

A 690-page compilation of scientific data on the oceanography and renewable resources of the northern Gulf of Alaska has been published by the University of Alaska's Institute of Marine Science (IMS). The publication, **"A Review of the Oceanography and Renewable Resources of the Northern Gulf of Alaska,"** two years in preparation, was financed by the Western Oil and Gas Association and Alaska Sea Grant Program.

Editor of the publication is Donald H. Rosenberg, associate professor of marine science at IMS. Donald W. Hood, director of IMS, and one of the contributors describes the compilation of existing data on the gulf region as the most complete yet assembled. It is a summary of present knowledge and advocates nothing, Hood says.

Much of the study is devoted to the Gulf of Alaska fisheries, the king crab, tanner crab, dungeness crab, shrimp, scallop, clam, halibut, groundfish and salmon fisheries. There are sections on oil seeps and weather in the broad region.

Among other contributors to the new university publication are Victor B. Scheffer, now chairman of the Marine Mammals Commission appointed by President Nixon; F. Heward Bell, former director of the International Halibut Commission; and Max Katz of the University of Washington's College of Fisheries. University of Alaska scientists who contributed sections also include Brina Kessel of the College of Biological Sciences and Renewable Resources; Robert Carlson, director of the Institute of Water Resources; and Howard M. Feder, Robert T. Cooney, Thomas C. Royer, F.F. Wright, and Linda Longerich of IMS. Copies of the report are available through IMS.

SALT-WATER ANGLING SURVEY FOR 1970

The **1970 Salt-Water Angling Survey**, offering a wide range of information on marine sport fishing, has been issued by the Statistics and Market News Division of the National Marine Fisheries Service. It includes estimated numbers of salt-water sport fishermen, methods used, and the size, weight, and area of catches, categorized into 79 species groups. As an aid to clarity, there is also an index of common fish names.

Statistics in this report will be valuable to conservationists, environmentalists and fishermen. The 1970 Salt-Water Angling Survey is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price is $0.85 domestic postpaid, or $0.60 in G.P.O. bookstores.

Recent NMFS Scientific Publications

NOAA Technical Report NMFS SSRF-673. Steimle, Frank W., Jr. and Richard B. Stone. **"Abundance and distribution of inshore benthic fauna off southwestern Long Island, N.Y."** December 1973. 50 p.

ABSTRACT

This paper describes a qualitative and quantitative census of the inshore benthic fauna off southwest Long Island over the period February 1966 through January 1967, prior to construction of an ocean sewer outfall in the general vicinity. Preliminary analyses of data indicate the presence of three distinct communities: 1) an inshore medium to course grain sand community dominated by the bivalve, *Tellina agilis*, the amphipod, *Protohaustorius deichmannae*, and the echinoderm, *Echinarachnius parma*, 2) an offshore silty fine sand community dominated by the bivalve, *Nucula proxima*, and the polychaete, *Nephtys incisa*; and 3) a community dominated by the blue mussel, *Mytilus edulis*.

Data Report 81. Cook, Steven K. **"Expendable bathythermograph observations from the NMFS/MARAD Ship of Opportunity Program for 1971."** 132 p. (3 microfiche). For sale by U.S. Department of Commerce, National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22131.

ABSTRACT

Results of the first year of operation of the NMFS/MARAD Ship of Opportunity Program in the form of horizontal and vertical distributions of temperature are presented. Operational procedures and problems and data management also are discussed.

NOAA Technical Memorandum NMFS ABFL-2. Trautman, Milton B. **"A guide to the collection and identification of presmolt Pacific salmon in Alaska with an illustrated key."** November 1973. 20 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

ABSTRACT

This field and laboratory key contains recommendations for

types of equipment needed, instructions for preserving and labeling specimens, and descriptions of the characters used in identifying five species of Pacific salmon. The key is illustrated with six line figures: 1) juvenile salmon, 2) the first gill arch, 3) head with gill arch in situ, 4) first gill arch and eye for comparison with longest rakers, 5) method of counting anal fin rays, and 6) ventral surface of head showing branchiostegals. Five plates of stippled line drawings of five lengths (25 to 110 mm fork length) for each of the five species of Pacific salmon, an annotated opposable key, and a glossary are also included.

NOAA Technical Report NMFS CIRC-385. Thorson, Lee C. and Mary Ellen Engett. **"Fishery publications, calendar year 1972: lists and indexes."** November 1973. 23 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

ABSTRACT

The following series of fishery publications of the National Marine Fisheries Service, National Oceanic and Atmospheric Administration, in calendar year 1972 are listed numerically (with abstracts) and indexed by author, subject, and geographic area: NOAA Technical Report NMFS CIRC (formerly Circular); Data Report; Fishery Facts; NOAA Technical Report NMFS SSRF; and NOAA Technical Memorandum NMFS.

Sea Grant Marine Science Publications

NOAA's National Sea Grant Program awards grants primarily to colleges and universities for programs designed to develop and conserve marine resources. Activities in research, education, and marine advisory services are supported at institutions on all salt water coasts and on the Great Lakes. Publications are a major output of the program and recent Sea Grant publications are listed below. Publication requests should be directed to the author or the originating institution.

A Determination of Budgets of Heavy Metal Wastes in Long Island Sound: First Annual Report: Parts 1 & 2, by Peter Dehlinger, et al., 50 fig., 23 tables, 1 photo, 5 appendices, 189 pp, June 1973. University of Connecticut, Marine Sciences Institute, Groton, CN 06340.

ABSTRACT

Investigations of heavy metal wastes in Long Island Sound are reported. Budgets of potentially harmful wastes are determined through five integrated research projects: fates and concentrations of heavy metals in the water column, concentrations and effects of metals in oysters, water circulation patterns controlling water renewal times and flushing rates, structure and motion of the outflow of the Connecticut River, and transport of suspended materials.

What Seafood Processors Should Know About *Vibrio parahaemolyticus* by J. S. Lee, 4 pp. From J. of Milk and Food Technology, August 1973, Vol. 36, No. 8. Dept. of Food Science and Technology, Oregon State Univ., Corvallis, OR 97331.

ABSTRACT

Information on *Vibrio parahaemolyticus* that is pertinent for its control in food processing operations is compiled and discussed in this paper. The growth potential of this organism and requirement for NaCl are discussed in some detail. Effects of temperature, pH and antimicrobial agents are also presented.

Syllabus of Fish Health Management by George W. Klontz, 227 pp, December 1973. Price $10. TAMU-SG-74-401, Sea Grant Program, Texas A&M Univ., College Station, TX 77843.

ABSTRACT

This manual covers fish culture methods and fish disease diagnosis. Fish culture is discussed in terms of the interrelationships of six basic components: fish, water, container, nutrition, management and money. At least eight categories of fish diseases, treatment, control and management problems arising from intensive propagation of fish are discussed.

Shrimp Fishing with Twin Trawls by David L. Harrington, Martin R. Bartlett, James Higgins, 5 fig., 28 photos, 10 pp, November 1972. Marine Extension Bulletin No. 1. Georgia Sea Grant Program, Univ. of Georgia, P.O. Box 1387, Savannah, GA 31406.

ABSTRACT

Twin trawl shrimp fishing techniques are explained with the aid of diagrams and photos. Methods of converting single and double-rigged boats to the twin trawl method are described.

The Menhaden Fishing Industry in North Carolina by Jonathan W. Whitehurst, 7 figs., 5 maps, 10 photos, 1 appendix, 59 pp, January 1973. UNC-SG-72-12. Sea Grant Program, Univ. of North Carolina, Chapel Hill, NC 27514.

ABSTRACT

Historical development of the menhaden fishing industry is traced. Geographical distribution of the fishery is analyzed in terms of contributing factors such as the continental shelf, estuaries, and food availability. Industrial organization, techniques and spatial distribution are discussed along with problems and prospects facing the menhaden fishing industry.

Natural Resources Management in the Great Lakes Basin by James Arthur Burkholder, 3 charts, 186 pp, May 1973. Great Lakes Management Problems Series. New York State Sea Grant Program, 99 Washington Avenue, Albany, NY 12210.

ABSTRACT

The problem of developing a proper institutional framework for effective natural resources management in the Great Lakes Basin is discussed. The present system of conflicting jurisdictions is analyzed and a model for an international Canadian-American Great Lakes management system, based on the existing International Joint Commission (IJC), is discussed. Two possible phases of development are presented for the model IJC, which would have broad international powers for research, policy-making and administration.

Legal Impediment to the Use of Interstate Agreements in Coordinated Fisheries Management Programs; States in the NMFS Southwest Region by H. Gary Knight, T. Victor Jackson, 4 appendices, 120 pp, September 1973. Louisiana State Univ. Sea Grant Legal Program, Baton Rouge, LA 70803.

ABSTRACT

Existing and alternative systems for coordinated interstate marine fisheries management are identified and analyzed. Four major areas are discussed: present jurisdictional arrangements and problems; issues involved in developing the management program; existing state management systems in the NMFS Southeast Region; and recommendations to facilitate in the use of interstate agreements.

An Evaluation of a Proposed Solution for the Marine Insurance Problems of the Texas Shrimping Industry by Wayne E. Etter, 2 graphs, 8 tables, 1 exhibit, 44 pp, August 1972. Price: $2.00. TAMU-SG-74-202. Texas A&M Univ. Sea Grant Program, College Station, TX 77843.

ABSTRACT

The 44-page report attempts to analyze statistically the problem of extremely high insurance costs of the Texas shrimping industry and to evaluate proposed solutions. Marine insurance data based on questionnaires sent to Texas Shrimping Association members are analyzed according to average premium rates, loss ratios, principle causes of loss and premium rate variances. The industry-owned "captive" insurance company concept and the Pike/Anco group insurance proposal are both evaluated in terms of their long and short-term effects.

A New Look at Sharks by Elizabeth Keiffer, 1 photo, 1 p, September 1972. No. 40. New England Marine Resources Information Program, Univ. of Rhode Island, Narragansett 02882.

ABSTRACT

Narragansett Laboratory shark program studying migration, distribution, food and reproductive habits of Atlantic sharks is described. Possible new roles for sharks as sport fish and food resources are discussed.

Two New Bilingual Fisheries Manuals

A bilingual English-Spanish bulletin explaining the importance of cleanliness in seafood processing is available from the Center for Marine Resources, Texas A&M University. **"Seafood Quality Control: A Manual for Processing Plant Personnel,"** by Dr. Ranzell Nickelson, is aimed at helping seafood plant workers understand how bacteria can affect food, cause spoilage and create public health problems.

The manual answers questions that seafood processing plant employees might ask about certain practices they are required to follow. It is illustrated with drawings and photographs of bacteria and growing bacteria cultures. The importance of each worker's cleanliness to the quality of the plant's final product is stressed in the text.

English and Spanish translations are placed side by side. Each illustration also is explained in both languages. Manuel Pina, Jr., Extension Service Information specialist, prepared the Spanish text. The bilingual quality control manual is the third in a series of four publications about seafood quality. The first bulletins, "Boats and Fish Houses" and "Processing Plants," are available in English only. The final publication of the series, now being prepared, will describe tests and procedures for quality control laboratory personnel. These free publications are available by writing the Center for Marine Resources, Texas A&M University, College Station, TX 77843.

"A Review of the Salmon Hatcheries of the Republic of Korea," by Clinton E. Atkinson et al. published by U.S. Dept. of State (AID) and Republic of Korea Office of Fisheries in Seoul in October 1973 (bilingual edition, Korean and English). Reports on recent attempts to restore and extend coho and chum salmon runs in the Republic of Korea, using in part eggs imported from the United States.

A hatchery program begun in 1968-1969 did not produce the runs expected in 1972, and consequently a team of Korean and U.S. experts examined the situation. This book is a report of their findings and includes discussion of environmental and operational conditions, particularly of water temperature and timing of releases at each hatchery; analysis of these conditions; and recommendations for improving the hatchery program. The book, 263 pages (142 pages in English), is available on loan from Translation Program, International Activities Staff, Fx41, NMFS, NOAA, U.S. Department of Commerce, Washington, DC 20235.

Editor's Comments

More on Gigi

> Being on the coast of California in 1852, when the "gold-fever" raged, the force of circumstances compelled me to take command of a brig, bound on a sealing, sea-elephant, and whaling voyage, or abandon sea-life, at least temporarily. The objects of our pursuit were found in great numbers, and the opportunities for studying their habits were so good, that I became greatly interested in collecting facts bearing on the natural history of these animals.

With such forthright 19th century prose does Charles Melville Scammon open his classic account of "The Marine Mammals of the North-Western Coast of North America and the American Whale Fishery." The book was published just a century ago, in 1874. It sold poorly, according to Victor Scheffer's introduction to the 1968 Dover edition. But over the years it became increasingly popular, rare, and expensive. First editions are now bibliographic treasures. Luckily, there are today excellent and relatively inexpensive facsimile editions, including reproductions of the striking lithographs that illustrated the first.

Scammon was born in 1825 and hence was 27 when he began his career as the captain of a whaling ship. He eventually joined the U.S. Revenue Marine, a predecessor of the Coast Guard, and the byline of the book gives his affiliation as a Captain of that organization. He died in 1891.

There is an extensive literature on the California gray whale. For a brief, authoritative, and well-written scientific summary of what was known of the creature before the Gigi studies, I highly recommend "The life history and ecology of the gray whale *(Eschrichtius robustus)*," by Dale W. Rice and Allen A. Wolman, Special Publication No. 3, The American Society of Mammalogists. This was published in April 1971, almost coincidentally with the capture of Gigi, an event which made possible a host of studies previously impossible. A very good popular account of contemporary whale studies, including those on Gigi, was written by Faith McNulty and appeared in *The New Yorker* last year.

• The name Gigi, one supposes, was borrowed from the enchanting heroine of Colette's short novel. Three delightful actresses portrayed the fictional Gigi: Danielle Delorme in a French movie version that was one of the funniest and least widely seen pictures ever made (it was bought up by the producers of the American screen "Gigi"), Audrey Hepburn, who first made her name by playing the part on the stage in London and New York, and Leslie Caron, who starred in the unforgettable screen musical. And there is still another Gigi, playing in a stage version of the musical now running in New York. It is difficult to equate these slender and girlish beauties with a creature that was almost 20 feet long and weighed 2 tons at capture and who for some months gained weight at a rate of three pounds an hour.

• William C. Cummings of the Naval Undersea Center in San Diego has been studying marine mammals for a decade or so. (We published a paper he wrote with Paul O. Thompson, "Gray whales, *Eschrichtius robustus*, avoid the underwater sounds of killer whales, *Orcinus orca*," in the *Fishery Bulletin*, Vol. 69, p. 525.) Shortly after the 1973-74 holidays he wrote a letter I think will be of interest to some of our readers:

> During the past 10 years of my involvement with marine mammals, I have experienced and heard incidents of their unfortunate collisions with large and small watercraft. The animals doubtlessly try their best to avoid these contacts, but are we doing our share?
>
> In a few moments of introspection over the holidays an idea came to mind which may offer some mitigation of man's burdening threat to the living environment. If we could learn more of the circumstances involved, perhaps a means may be found for helping to reduce the mutually harmful collisions between aquatic mammals and watercraft. And if this should not appeal to your altruism alone, think of the benefits to science, including possible new information on visual capability, hearing, activity rhythms, or general awareness of these animals. A good behaviorist could design and implement field experiments to satisfy both requirements, given enough time and funding. However, in this austere period for research, a promising start seems to be in calling upon the experiences of all boat users, whatever their purpose.

Cummings has designed a one page data sheet, headed "Collisions with aquatic mammals," which he hopes boat users will fill out and return to him so as to make a beginning on the project. "To avoid obvious biases," he says, "reported incidents should not include contacts involving unintentional observers who may have been overzealous in their attempt to view seals, whale, porpoises, or others at close range. Perhaps you may not have had a pertinent experience, but could possibly help us to uncover additional information from an acquaintance with this experience, or from something already published. Participants will receive a report of the findings and acknowledgement of their assistance.

"It is gratifying to find tangible effects already emerging from man's attempts to protect aquatic mammals, and it is my sincere wish for the New Year that this survey will in some way contribute to this effort."

Readers of this publication would be performing a valuable service to our increasing understanding of the whales and other marine mammals if they would make their knowledge available to Dr. Cummings. T.A.M.

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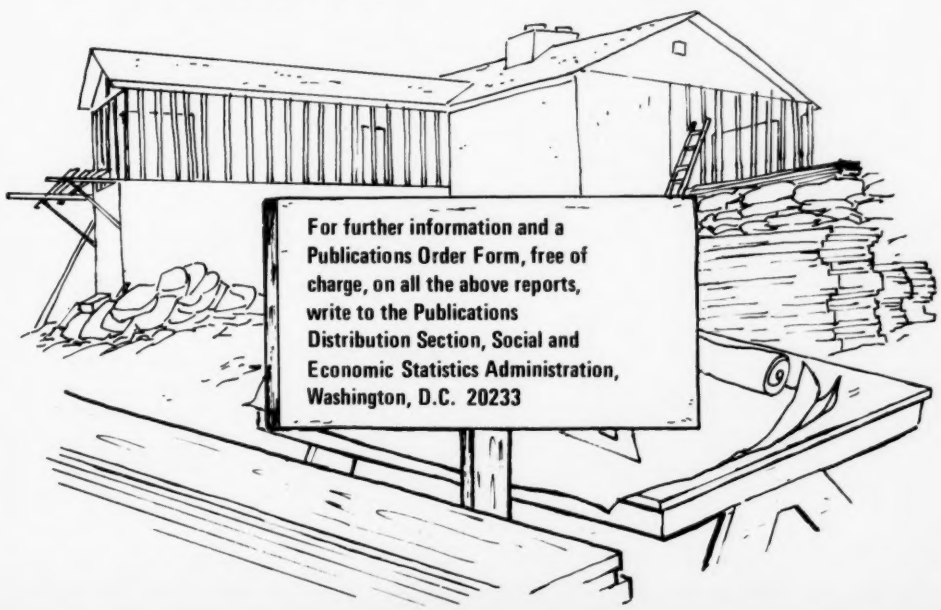
CURRENT CONSTRUCTION REPORTS

CONSTRUCTION accounts for approximately 12 percent of the gross national product!

To assist industry representatives, research specialists, market analysts, and government officials interested in this vital segment of the Nation's economy, the Bureau of the Census issues **monthly, quarterly,** and **annual** reports on the value of new construction put in place, building permits, housing starts, housing completions, housing sales, alterations and repairs and demolition of residential structures.

Current Construction Reports include:

C20 - Housing Starts
C22 - Housing Completions
C25 - Sales of New One-Family Homes
C30 - Value of New Construction Put in Place
C40 - Housing Authorized by Building Permits and Public Contracts
C41 - Authorized Construction–Washington, D.C. Area
C45 - Permits Issued for Demolition of Residential Structures in Selected Cities
C50 - Expenditures on Residential Additions, Alterations, Maintenance and Repairs, and Replacements



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